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# THE EFFECT OF THE NUNN–MCCURDY AMENDMENT ON UNIT-COST-GROWTH OF DEFENSE ACQUISITION PROJECTS

by

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## CENTER FOR PUBLIC POLICY AND PRIVATE ENTERPRISE

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# Executive Summary

The Department of Defense (DoD) has faced significant acquisition problems over an extended period of time. As noted by one GAO report, the "DoD's major weapon system programs continue to take longer, cost more, and deliver fewer quantities and capabilities than originally planned" (Sullivan, 2008). For example, the programs that comprise the DoD's Major Defense Acquisition Projects (MDAPs)[1] for 2007 had an average program cost-growth of 26% when compared to initial estimates, which collectively culminated in $295 billion dollars in additional costs (Sullivan, 2008). Given other pressing financial obligations, the DoD cannot afford to incur in the future similar development problems as it has experienced in the past.

Cost-growth is defined as the positive difference between actual cost and budgeted costs. Due to its relative ease of measurement, cost-growth provides a simple barometer to determine if the acquisition process is achieving its stated goals. Since the 1950s, numerous reports have found that, in general, the DoD's acquisition process experiences high cost-growth at both the program and unit levels.

Congress has made several attempts to implement reforms that would control program and unit-cost-growth, but these have not achieved their intended results. The most direct policy that attempted to curtail unit-cost-growth was the Nunn–McCurdy Amendment (NM), which Congress implemented in 1982. The law was significantly modified in 2006 and 2009 (as described below).

NM requires the DoD to report when unit-cost-growth of any major defense acquisition program is "known, expected, or anticipated" by a program manager to exceed certain cost-growth thresholds ("The National Defense Authorization Act for Fiscal Year 2010," 2009c). More specifically, NM stipulates two levels of unit-cost-growth breach: the "significant" level and the "critical" level. A significant unit-cost breach occurs if a program experiences cost-growth over 15% of the current baseline estimate, whereas a critical unit-cost breach occurs if a program experiences cost-growth of 25% over the

1 Major Defense Acquisition Projects are DoD's largest programs, which represent roughly 80% of the DoD's acquisition budget in a given year (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007).

current baseline estimate.  This unit-cost breach occurs if a program experiences unit-cost-growth above specified thresholds, either as measured by total-program acquisition unit-cost[2] (PAUC) or average procurement unit-cost[3] (APUC).

The NM law requires a program manager to fulfill specific criteria when a program breaches.  For a significant unit-cost breach, the "Service Secretary must notify Congress within 45 days after the report (normally program deviation report) upon which the determination is based … [and] submit a *Selected Acquisition Report* (*SAR*) with the required additional unit-cost breach information" (Axtell & Irby, 2007).  For a critical unit-cost breach, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) must fulfill all significant breach requirements, and must additionally certify to Congress within 60 days of the *SAR* that the program meets four criteria: (1) the system is essential to national security; (2) there are no alternatives to such a system that will provide equal or greater military capability at less cost; (3) the new estimates of the unit-cost are reasonable; and (4) the management structure for such a major defense system is adequate to manage and control unit-cost ("The National Defense Authorization Act for Fiscal Year 2010," 2009c).

From 1982 to 2006, implementation of NM did not seem to have any significant impact on acquisition outcomes.  The most consistent criticism of NM was that the measure was ineffective because programs would avoid incurring an NM breach by rebaselining a program (i.e., establishing a new "current" baseline)—a procedure that did not require Congressional notification (Axtell, 2006).

The NM statute was amended in 2006 to close the rebaselining loophole.  The new provision included language specifying a second condition for incurring an NM breach: unit-cost-growth over the *original* baseline estimate.  A significant unit-cost breach occurs when cost-growth exceeds 30% of the original baseline and a critical unit-cost breach occurs when cost-growth exceeds 50% of the original baseline estimate.  The revision did not change the reporting requirements for either the significant or critical unit-cost breach.

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2 (Total Development Cost + Procurement Cost + Construction Cost) / (Total-Program Quantity)
3 (Total Procurement Cost) / (Procurement Quantity)

Soon after the implementation of the 2006 NM revision, the DoD reported that 40 of the 85 current MDAP programs were experiencing unit-cost-growth high enough to warrant a Nunn–McCurdy breach. Although 25 of these programs experienced unit-cost-growth of over 50% relative to their original baseline, the DoD did not report programs as having incurred a Nunn–McCurdy breach because the National Defense Authorization Act permitted the “original baseline estimate to be revised to the current baseline estimate as of January 6, 2006” (Office of the Under Secretary of Defense (Acquisition Resources and Analysis), 2006). Between 2006 and 2007, 16 additional programs experienced unit-cost-growth high enough to incur an NM breach. Despite the impact of the new legislation on the number of programs that breached, it is too soon to determine the long-term impact of the legislation on current acquisition performance, even though the immediate short-term impact has been to provide greater visibility as well as to place a great deal more emphasis on the unit-cost-growth relative to the original program baseline.

Congress again amended NM by passing the Major Weapons Systems Acquisition Reform Act of 2009. This law added two requirements to the process of recertifying programs that incur an NM breach. A program with an NM unit-cost breach now must (a) rescind the most recent Milestone approval and (b) receive a new Milestone approval before any actions regarding the contract may continue. The new Milestone approval requires a certification that the costs of the program are reasonable, and the certification must be supported by an independent cost estimate that includes a confidence level for the estimate ("Weapon Systems Acquisition Reform Act of 2009," 2009). This statute was implemented too recently to evaluate its impact upon the defense acquisition process.

The authors performed several data analyses, based on limited, publicly available information, to determine if any reported variables were correlated in a statistically significant way with NM unit-cost breach. The data analysis computed several tests of independence, using Fisher’s “exact test.” This analysis produced two conclusions. First, the DoD’s current metrics are not useful for determining the root cause of unit-cost-growth in acquisition programs. Second, despite data limitations, it appears that programs that experience high unit-cost-growth are not randomly distributed. Going further, programs that experience an NM unit-cost breach appear to have the strongest relationship with two factors: dollar size of the project and the *Selected Acquisition Report*'s estimating cost category. Programs appear much more likely to breach if the total-program has a large value (above $7.95 billion) and if the cost-growth is attributed to the estimating category, which measures the accuracy of the program's initial estimates. Conversely, programs with small total-program value (below $3.5 billion) appear to rarely breach.

The report analyzed two relevant case studies: The Space-Based Infrared System (SBIRS) –High and the Virginia-class Submarine (SSN-774) program. The Space-Based Infrared System (SBIRS)–High program highlights how the threat of an NM breach does not necessarily lead to improved acquisition outcomes. The Virginia-class Submarine (SSN-774) program underscores how programs that experience high unit-cost-growth can implement policies to achieve substantial cost-reductions (i.e., take actions to avoid an NM breach).

Our study resulted in eight findings: (1) unit-cost-growth has remained high since NM was implemented in 1982; (2) few programs incurred an NM breach until the recent 2006 revision of the law that requires programs to consider unit-cost-growth above the program's original baseline; (3) the DoD's data collection has been inconsistent (with regard to definitions, moving baselines, quantities, etc.); (4) the DoD often has not conducted systematic analysis of root-cause problems; (5) limited and inconsistent data undermines an effective analysis; (6) NM may identify acquisition problems too late in the development process to allow program reforms to be effective; (7) NM's effectiveness may be limited by its focus on the development and procurement of assets, as opposed to the entire lifecycle of the program; and (8) recent legislation has not been implemented long enough to evaluate its impact on DoD acquisition processes.

The authors developed nine recommendations. Regarding NM, the DoD should (1) develop a system to determine and distribute lessons learned from an NM breach throughout the DoD and (2) develop leading indicators. In order to control cost-growth, the DoD should (3) fully embrace and implement the legislation in the Weapon Systems

Acquisition Reform Act of 2009 (because prior attempts to reform DoD acquisitions have been ineffective in large part due to the DoD's institutional resistance); (4) identify cost as a development requirement of equal importance to schedule and performance; (5) implement a more complete acquisition-data information system; (6) consider lifecycle costs when rendering acquisition decisions; (7) directly address the lack of incentives that allow current underlying problems to persist; (8) work with Congress to increase funding flexibility (e.g., being able to use production money to increase development costs, so as to save the far more significant unit production costs); and (9) provide programs with greater requirements flexibility (e.g., allowing cost/performance tradeoffs, especially for block I of the deployed system,[4] so that the last 5–10% of performance "requirements" don't double the unit-costs).

4 *Block I* refers to the assumption that, after initial fielding, the program will utilize "spiral development" to achieve higher performance in subsequent blocks.

# I. Introduction

The Department of Defense (DoD) continues to face acquisition challenges. As noted by one GAO report, the "DoD's major weapon system programs continue to take longer, cost more, and deliver fewer quantities and capabilities than originally planned" (Sullivan, 2008). For example, the programs that comprise the DoD's Major Defense Acquisition Projects (MDAPs)[5] for 2007 had an average program cost-growth of 26% when compared to initial estimates, representing approximately $295 billion dollars in additional costs (Sullivan, 2008). These programs also experienced, on average, a 21-month delay in delivering initial capability to warfighters (Sullivan, 2008). Unfortunately, the DoD has experienced similar development problems since at least the 1950s (Frank, 1997). The DoD expects to spend approximately $935 billion dollars on acquisition between fiscal years 2009–2013 (U.S. Department of Defense, 2009). Given the nation's other pressing financial obligations, the DoD will need to find ways to develop and acquire its needed capabilities more efficiently.

The DoD has implemented several reforms to control program and unit-cost-growth. Congress most explicitly addressed this issue in 1982 when it implemented the Nunn–McCurdy Amendment (NM), which established mandatory reporting requirements for programs that experience specified levels of unit-cost-growth. Despite additional legislation—including recent revisions of NM in 2006 and 2009—defense acquisition projects continue to experience high unit-cost-growth. However, it may be too early to fully determine the impacts of the recent revisions.

### Cost-growth

Cost-growth is the positive difference between actual or projected cost and budgeted or initial estimated costs. Thus, cost-growth can be calculated in a variety of ways, depending on technique.

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5 Major Defense Acquisition Projects are DoD's largest programs, which represent roughly 80% of the DoD's acquisition budget in a given year (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007).

Although this metric is not inferential, cost-growth is widely used because it is a simple measure to help gauge the effectiveness of the acquisition process.

**Cost-growth Studies**

The DoD's MDAPs have experienced high program and unit-cost-growth over an extended period of time. Despite data limitations, numerous reports issued over the past 50 years have noted high program cost-growth. Seven of these studies are summarized in Figure 1. The reports, written between 1959–2006, cover programs between 1946–2003. All studies adjusted program cost-growth for inflation and quantity change relative to the MS II baseline, although the studies did not necessarily make such adjustments in the same way (Arena, Leonard, Murray, & Younossi, 2006).

Several limitations in the analysis of our report must be noted. First, due to differences in (a) calculating program cost-growth and (b) sample set characteristics (such as which development phases are included in analysis), the results from these studies are not necessarily comparable. Second, most reports included data for ongoing programs, further complicating comparisons between reports. Since ongoing programs will potentially experience additional program cost-growth, most reports do not account for the total cost-growth of a program. Therefore, it is possible for two separate reports that used the same cost methods and samples sets to arrive at different results, depending on when the data were collected. Third, because reports only use sample sets of programs that are in development during respective time periods, reports at best estimate cost-growth for a specified time period. At present, no comprehensive, publicly available analysis exists that includes most DoD projects over an extended period of time. Finally, most programs use information provided by the *Selected Acquisition Report*, a reporting mechanism that has been criticized for its limitations. The *SAR* and its shortcomings will be discussed more thoroughly in a later section. A short summary of its drawbacks include (a) inconsistent reporting practices; (b) only reporting information on MDAPs, thereby excluding a large number of lower cost programs from analysis; and (c) truncating reporting once a program has either received 90% of the items it purchased or has expended 90% of its planned expenditures, thus not tracking costs throughout the most expensive portion of a system's life, sustainment.  Despite these limitations, an analysis based on the available data is better than no analysis of a situation.

Program cost-growth is recorded as a cost-growth factor (CGF) relative to the total-program's original estimate.  The development CGF represents program cost-growth that occurred during the Research, Development, Test & Evaluation (RDT&E) phase of acquisition.  From reports that record this information, the development program cost-growth factor ranged from 1.25 to 1.58.  The procurement CGF represents growth during the production of a system.  From reports that record this information, procurement CGF ranged from 1.18 to 1.65.  Total CGF, which includes program cost-growth that occurred during both the development and procurement of a program, showed a greater range of values—from a low of 1.14 to a high of 3.23.  In short, reports from different time periods all recorded high program cost-growth, although large differences existed.

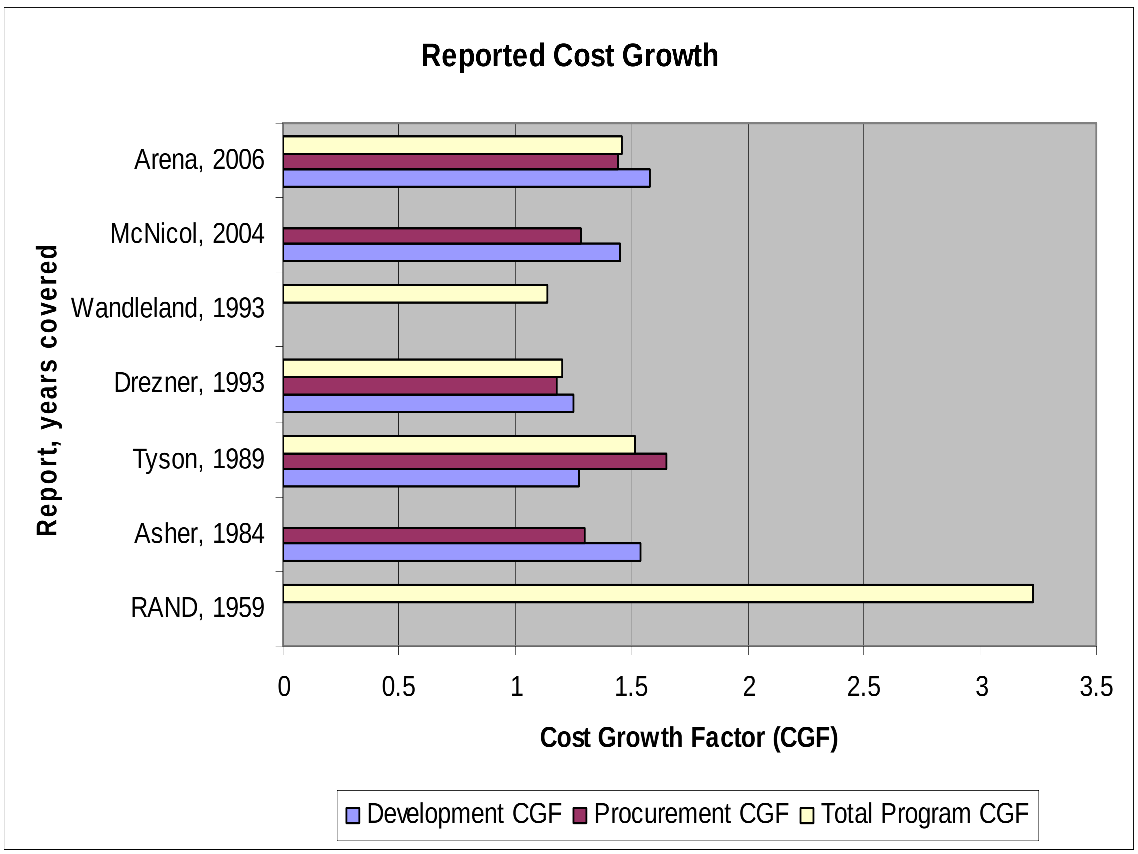


**Figure 1: Graphical results of past cost-growth reports**
Source: (Arena, Leonard, Murray, & Younossi, 2006).

## Cost-growth Longitudinal Studies

To properly evaluate if program cost-growth has changed over time, however, one should also address changes in cost-growth over time. The authors found two such analyses, the results of which are reproduced in Figures 2 and 3.

This type of analysis also has limitations. First, these two analyses are not directly comparable because the authors of the analyses utilized different methodologies (more specifically, the authors of the first study did not adjust for changes in quantity, whereas the authors of the second study did). Second, both analyses include programs that are still in development. These programs may experience additional cost changes before completion of the program, potentially underreporting cost-growth. Third, and related to the prior concern, programs grouped by decade are likely to display selection effects. More specifically, ongoing programs in the decade closest to a report's publication are likely to underestimate program cost-growth because programs represented are at a relatively early part of their lifecycles. For this reason, the data for programs initiated closest to the publication of the report should be viewed with the most skepticism. Fourth, these analyses do not include data about those programs currently under development. Such programs would be most indicative of current acquisition trends. Finally, as most MDAPs are acquired over decades, a longitudinal analysis may be of limited usefulness in determining the effectiveness of singular policies. New policies are unlikely to be fully effective for those programs that have already been in development for an extended period of time, due in large part to prior programmatic decisions, potentially undermining the perceived impact of a specific policy. Clarity can also be obscured in the long-run, however, because acquisition policies tend to turn over faster than the DoD's acquisition portfolio. Nonetheless, as asserted before, examination of a limited analysis is superior to the absence of analysis.

The first study is entitled *The Effects of Management Initiatives on the Cost and Schedules of Defense Acquisition Programs* and was issued by the Institute for Defense Analyses in 1992. This study analyzed 100 programs for their development cost-growth and a subset of 82 programs for their production cost-growth. Only programs that had been in full-scale development for at least three years were analyzed for development cost-growth, and only programs that had been in full-scale production for at least three years were analyzed for production cost-growth. The report noted that “nearly all programs in the sample are either still in production and in service, or are previous versions of weapon systems that are still in production or in service” (Tyson, Om, Gogerty, Nelson, & Utech, 1992). Although the report provided information regarding the causes of cost-growth in the development phase, similar information was not provided for the procurement phase. The results of this study are represented in Figure 2. A quick analysis across time reveals that development cost-growth has apparently shrunk moderately between the 1960s and 1980s. Production and total cost-growth appears to shrink between the 1960s and the early 1970s, but rebounds by the late 1970s (more recent data is less likely to be reliable, for reasons noted above). Although development cost-growth in the late 1970s and 1980s is lower than the 1960s and early 1970s, these eras are more likely to see an increase in program cost-growth because such programs were still relatively early in their lifecycles at the time the report was issued in 1992. For instance, the report noted that the projects of the 1980s experienced, on average, a 32% delay in development schedule. This is a strong indicator that program cost-growth will increase significantly in the future—although the extent of this growth is uncertain. Overall, it is clear that program cost-growth has remained at very high levels throughout the time period considered. Although program cost-growth may have improved during the early 1970s, it appears unlikely that program cost-growth decreased significantly over the time period considered.

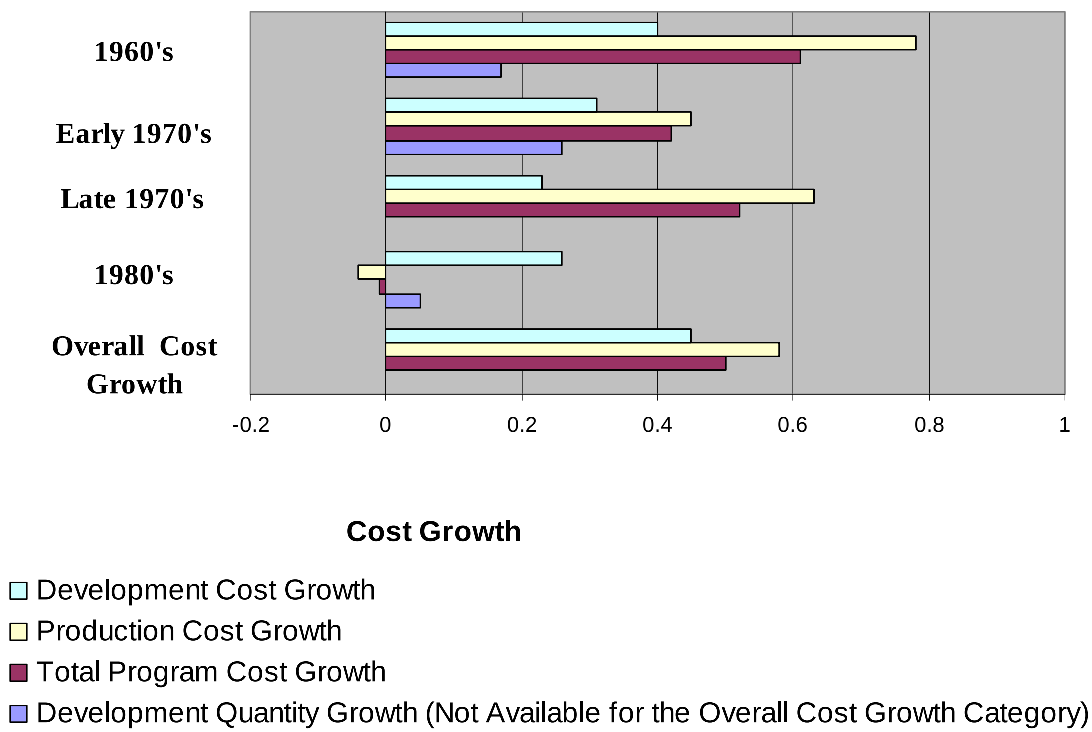


**Figure 2: Institute for Defense Analyses, "The Effects of Management Initiatives on the Cost and Schedules of Defense Acquisition Programs" study results (1992)**
Source: (Tyson, Om, Gogerty, Nelson, & Utech, 1992)

The second report is entitled *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs* and was issued by the RAND Corporation in 2007. This report analyzed development cost-growth for complete and ongoing programs. The report analyzed 46 completed projects (defined as cessation of *SAR* reporting) and 33 ongoing programs (limited to programs that were at least five years beyond Milestone B). The results of the study are reproduced in Figure 3.

The RAND report reported cost-growth was adjusted for changes in quantity. From the *SAR* data, the RAND report's authors developed a "cost improvement curve (CIC) to rationalize the quantity actually procured with that of the baseline estimate … [by adjusting] the baseline estimate procurement costs from the baseline's estimated quantity to the program's final quantity" (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007).

In Figure 3, the leftmost column (white) indicates the development cost-growth for completed programs. According to their analysis, development cost-growth was almost

80% in the 1970s and 60% in the 1980s. Development cost-growth dropped off markedly in the 1990s, but, as noted in the report, this observation is mainly due to selection effects—few programs started in the 1990s were completed during that decade, indicating those programs that were completed (a) had a shorter development cycle and (b) did not face significant cost-growth. As a result, the leftmost column (completed programs) does not provide an accurate reflection of development cost-growth for all programs in development during the 1990s.

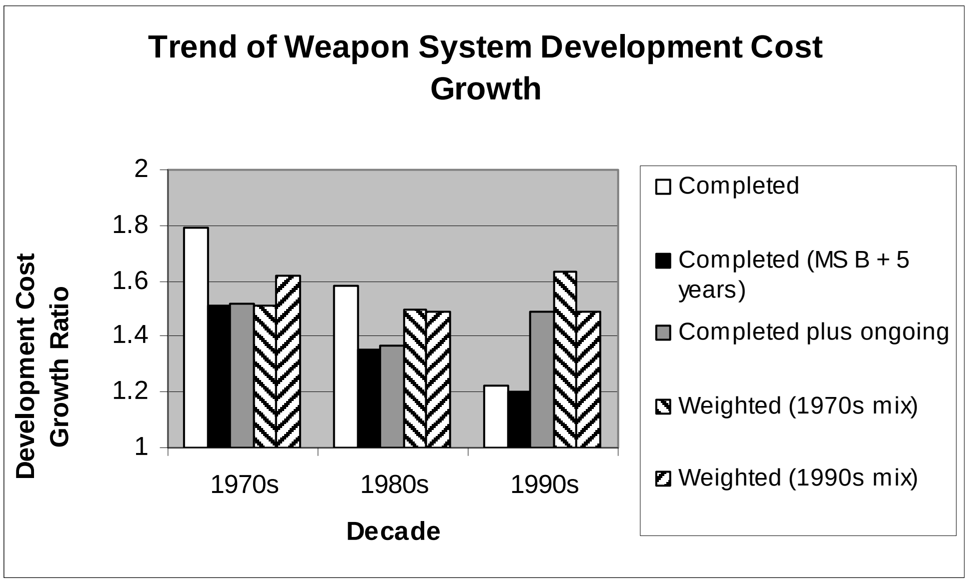


**Figure 3: RAND Corporation, *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs* study results (2007)**
Source: (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007)

The second column (black) in Figure 3 analyzes the same group of completed programs but at a similar stage of development, at five years past development Milestone B.[6] Development cost-growth was about 50% in the 1970s, 35% in the 1980s, and 20% in the 1990s. The indication is that programs five years past the MS B decision point continued to experience development cost-growth. Although development cost-growth again appears to fall considerably between the 1970s and 1990s, the authors of the RAND report again note that the data should not be taken wholly at face value. In short, the relatively small number of programs that begun and completed development in the 1990s are likely to have several traits that distinguish themselves from the normal portfolio of

6 Milestone B is a program checkpoint that the DoD requires for a program in order to move from the technology and development phase to the system development and demonstration phase.

DoD development programs. For example, these programs likely had short development cycles and did not experience significant schedule delays and cost-growth. As a result, the second column in Figure 3 does not necessarily provide an accurate reflection of development cost-growth for all programs in development during the 1990s.

The third column (grey) in Figure 3 analyzes all programs in the dataset, both completed and ongoing, at five years past MS B. Development cost-growth was approximately 50% in the 1970s, 35% in the 1980s, and 50% in the 1990s. This column more accurately indicates development cost-growth because it includes those programs most likely to experience high development cost-growth—the ongoing programs. This analysis appears to provide a credible evaluation of the cost-growth trend. From this information, it appears that development cost-growth improved between the 1970s and 1980s, but returned to the 1970s level by the 1990s.

The fourth (diagonal right stripes) and fifth (diagonal left stripes) columns in Figure 3 attempt to adjust for differences in development cost-growth over time due to the types of systems being acquired because development cost-growth has historically differed substantially between different types of weapons (Tyson, Om, Gogerty, Nelson, & Utech, 1992). The fourth column adjusted development cost-growth to approximate the 1970s mix of programs, whereas the fifth column did so for the 1990s mix of programs. RAND calculated these columns by "normalizing the contribution of each program type to [the development cost-growth factor] based on the proportions in the 1970s or the 1990s" (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007). Programs were divided into three categories: (a) aircraft and helicopters; (b) launch vehicles and satellites; and (c) missiles, electronics, and all other programs. The 1970s mix was approximately 39% missiles and electronics programs, 50% aircraft and helicopters programs, and 11% space programs, whereas the 1990s mix was approximately 66% missiles and electronics programs, 25% aircraft and helicopters programs, and 9% space programs.

The fourth column adjusted development cost-growth to approximate the 1970s mix of programs, measured at five years beyond MS B. This analysis produces relatively similar development cost-growth factors over time, with the 1970s and 1980s having a value of

1.5 and the 1990s having a factor of 1.6. By this analysis, development cost-growth increased slightly over the time period considered. The fifth column adjusted development cost-growth to approximate the mix of programs developed during the 1990s, again measured at five years beyond MS B. These results were the opposite of the fourth column: development cost-growth was highest in the 1970s (1.6), but it decreased during the 1980s and 1990s to 1.5. This analysis appears to show that development cost-growth has improved modestly since the 1970s for the data considered. But, as pointed out above, the 1990s column includes innovative, young, ongoing programs that are more likely than older programs to experience development cost-growth. As a result, depending on the outcome of programs currently in development, the 1990s may ultimately experience more development cost-growth than the other two decades.

### Cost-growth Analyses Conclusion

In conclusion, both of these longitudinal studies found that programs experienced high cost-growth—at least 50% over initial estimates—for an extended period of time. Perhaps more important, neither report identities a significant difference in the trend of program cost-growth over time (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007) (Tyson, Om, Gogerty, Nelson, & Utech, 1992). This finding is broadly supported by other cost-growth studies in both the private and public sectors (Ioannis A. Stratogiannis, and Christos K. Zahos 2008) (Government Accounting Office, 1981) (Schinasi, 2008).

### Reasons for Cost-growth

Reports have noted numerous reasons for persistent acquisition difficulties. For example, in Congressional Testimony Clark Murdock, Ph.D., Senior Adviser Center for Strategic and International Studies (CSIS), stated that the true root of the problem is that “the underlying incentive structure for defense acquisition is profoundly dysfunctional” (Murdock, 2008). A typical list of problems includes frequent requirements change, optimistically low estimates of program cost at project initiation, minimal use of risk estimates, use of immature technologies, production cycle stretch out, and poor management of contractors (Erwin, 2008). Figure 4 provides a more detailed list of reasons for program and unit-cost-growth. Due to the interrelated nature of many of these problems, which compound in effect, it is difficult to select one specific cause for cost-growth.

### Interrelated Development Difficulties

Although less reported than cost-growth difficulties, DoD faces similarly significant troubles delivering systems on schedule and at initial performance specifications. More often than not, problems with one of these three interrelated aspects frequently results in other cascading negative effects. For example, "delays in providing capabilities to the warfighter result in the need to operate costly legacy systems longer than expected, find alternatives to fill capability gaps, or go without the capability" (Sullivan, 2008). In this way, one program's schedule delay will likely lead to cost-growth, and possibly a reduction in capability for a program in development. Similarly, high-cost weapons growth leads to reduction in the number of units for a project or precludes the opportunity to invest in other projects, while fewer quantities of systems lower the capability of the military and increase the unit-cost of remaining items (a compounding effect). Because these acquisition difficulties are interrelated, programs that face challenges are rarely able to implement simple solutions.

| Problem Areas | Specific Problems |
|---|---|
| Requirements Definition | - Poor initial requirements definition<br>- Poor performance/cost tradeoffs during development<br>- Changes in quantity requirements |
| Cost Estimating | - Errors due to limitations of cost-estimating procedures<br>- Failure to understand and account for technical risks<br>- Poor inflation estimates<br>- Top down pressure to reduce estimates<br>- Lack of valid independent cost estimates |
| Program Management | - Lack of program management expertise<br>- Mismanagement/human error<br>- Over optimism<br>- Schedule concurrency<br>- Program stretch-outs to keep production lines open |
| Contracting | - Lack of competition<br>- Contractor buy-in (to win competition)<br>- Use of wrong type of contract<br>- Inconsistent contract management/administrative procedures<br>- Too much contractor oversight and too many reporting requirements<br>- Waste<br>- Excess profits<br>- Contractors overstaffed<br>- Unreasonable indirect costs for contractors<br>- Taking too long to resolve undefinitized contracts |
| Budget | - Funding instabilities within the DoD caused by trying to fund too many programs<br>- Funding instabilities caused by Congressional decisions<br>- Inefficient production rates due to stretching out programs<br>- Defense Acquisition Board (DAB)—formerly DSARC—out of synchronization with the Services' Program Objective Memorandum (POM) cycle<br>- Failure to fund for management reserve<br>- Failure to fund programs at most likely cost |
| Technical | - Use of immature technologies<br>- Adherence to strict performance requirements<br>- Reliance on proprietary information |

**Figure 4: Reasons for Cost-growth**

The information in this chart, except for the Technical subcategory, largely reflects the research of Harry M. Calcutt, Jr., presented in *Cost Growth in DoD Major Programs: A Historical Perspective* (Calcutt, 1993).

## II. The Defense Acquisition Reporting System

To better track costs and performance of defense acquisition programs, Congress has mandated, and the DoD has implemented, a number of reporting requirements that comprise the current defense acquisition reporting system. The primary purpose of this system is to provide decision-makers with timely, accurate, and consistent data so that they can make the most informed decisions possible regarding acquisition projects.

To achieve its goal, one of the principle objectives of the acquisition reporting system is to provide a mechanism to identify cost-growth and other development problems as early as possible. Different diagnoses require different solutions. In general, acquisition cost-growth could be primarily attributed to (1) estimate problems or (2) non-estimate problems.

Estimate problems indicate that cost estimates—particularly initial estimates—are overly optimistic. Poor estimates at the start of a program for cost, schedule, and performance produce an unsustainable development path. In this scenario, even if a program is managed optimally, the lack of required resources is likely to lead to an unsatisfactory program outcome.

The non-estimation category refers to all other issues that may contribute to cost-growth. Inefficiencies could arise due to managerial, technical, legal, budgetary, and/or cultural barriers that do not allow program offices to effectively manage their programs. The solutions to this broader set of barriers would be more complex. A comprehensive solution is likely to include several changes, such as enhanced training for program managers and reduced legal and budgetary limitations to effective acquisition.

Although acquisition difficulties are, to some degree, a product of both types of problems, as of yet no consensus exists regarding which type of problem is the principal concern; most likely, it is their interrelationship.

## History of the Acquisition Reporting System Prior to the Implementation of the Nunn–McCurdy Amendment (1967–1982)

### ***Selected Acquisition Report* (*SAR*)**

One of the first defense acquisition reform efforts was the introduction of the *Selected Acquisition Report* (*SAR*).

The DoD first introduced the *SAR* in 1967 as an internal reporting mechanism. In 1969, Congress mandated periodic status reports on major DoD programs (Leach, 2002). To fulfill this requirement, the DoD submitted the *SAR*. In 1977, Congress passed the Fiscal Year 1976/7T Authorization Act that established the *SAR* as a legal reporting document. Several years later, in 1983, Congress required all Major Defense Acquisition Programs to submit *SAR*s (Axtell, 2008). Over time, Congress would add additional requirements to the *SAR*.

Today, according to the United States Code, the purpose of the *SAR* is “to provide to the Committee on Armed Services of the Senate and the Committee on Armed Services of the House of Representatives the information such Committees need to perform their oversight functions” ("The National Defense Authorization Act for Fiscal Year 2010," 2009a). The *SAR* includes information such as a summarization of weapons development and procurement schedules; the current program acquisition and procurement unit-costs, along with the history of such costs; a full lifecycle cost analysis; and any other information deemed appropriate by the Secretary of Defense ("The National Defense Authorization Act for Fiscal Year 2010," 2009a). At the time of the *SAR*’s implementation, government agencies believed that “cost estimating is the key ingredient in reducing cost-growth” and that the *SAR* would improve such estimates by providing the DoD with its first department-wide acquisition reporting system (Sheley, 1982). More specifically, the information the *SAR* provided would allow decision-makers to evaluate the performance of acquisition projects, including determining if cost estimates were biased.

The DoD is required to submit a *SAR* for Major Defense Acquisition Projects (MDAPs), described in more detail below, at least once a year. This *SAR* report is due 60 days after the President's budget is released. If a program faces a problem—more specifically, a 15% increase in program acquisition or procurement unit-cost, or a six-month delay in program schedule—then the program must submit a *SAR* every fiscal quarter of the year, within 45 days after the end of the quarter. The quarterly report requires more detailed information than the annual report, including reasons why the program deviated from its current estimates. The final *SAR* is issued when a program has either received 90% of the items purchased or spent 90% of its planned expenditures (Axtell, 2008).

### Definition of a Major Defense Acquisition Project (MDAP)

To clarify which programs it desired information on, Congress legally defined a Major Defense Acquisition Project (MDAP) in 1987. A MDAP is defined as a not highly classified DoD program that is either "designated by the Secretary of Defense as a major defense acquisition program; or … estimated by the Secretary of Defense to require an eventual total expenditure for research, development, test, and evaluation of more than $300,000,000 (based on fiscal year 1990 constant dollars) or an eventual total expenditure for procurement of more than $1,800,000,000 (based on fiscal year 1990 constant dollars)" ("The National Defense Authorization Act for Fiscal Year 2010," 2009b). In 2008 dollars, a program qualifies as an MDAP if it has either an RDT&E cost of $486 million or a procurement cost of $2.918 billion.

### ***SAR*** **Limitations**

As originally implemented, the *SAR* had a number of limitations that undermined its effectiveness. Issues included inconsistent definitions of recorded metrics due to different agency reporting policies and procedures, resulting in data that were incomparable between projects, and, sometimes, for a given project over time (Bowsher, 1982) (Sipple, 2002); incomplete and fragmented recording of data, limiting timeliness and consistency of data for analysis (Hough, 1992); and an oversight agency's limited access to the *SAR* data due to unnecessary classification of information (Government Accountability Office, 2005). Because of these limitations, implementation of the *SAR* has not (a) significantly increased acquisition transparency or (b) helped to substantially reduce acquisition difficulties.

## III. Nunn–McCurdy Amendment

Concerned with persistent program and unit-cost increases in defense acquisition projects, Congress amended the 1982 Defense Authorization Act with the Nunn–McCurdy Amendment (NM). NM required the DoD to report, through the *SAR*, when unit-cost-growth of any major defense acquisition program was “known, expected, or anticipated” by a program manager to exceed certain unit-cost-growth thresholds ("The National Defense Authorization Act for Fiscal Year 2010," 2009c). The explicit purpose of the amendment was to help curb unit-cost-growth in acquisition projects. Congress made the amendment permanent in 1983. The statute would later be significantly modified in 2006 and 2009.

The original NM provision stipulated two levels of unit-cost-growth breach, the significant level and the critical level. A significant unit-cost breach occurred if a program experienced cost-growth over 15% of the current baseline estimate, whereas a critical unit-cost breach occurred if a program experienced cost-growth over 25% of the current baseline estimate. A unit-cost breach occurs if a program experiences unit-cost-growth above specified thresholds, as measured by either program acquisition unit-cost[7] (PAUC) or average procurement unit-cost[8] (APUC). For a significant unit-cost breach, the relevant “Service Secretary must notify Congress within 45 days after the [finding] (normally program deviation report) upon which the determination is based … [and] submit a *Selected Acquisition Report* (*SAR*) with the required additional unit-cost breach information” (Axtell & Irby, 2007). For a critical breach, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) must fulfill all significant breach requirements and must additionally certify to Congress within 60 days of the *SAR* that the program meets four criteria: (1) the system is essential to the national security; (2) there are no alternatives to the system that will provide equal or greater military capability at less cost; (3) the new unit-cost estimate is reasonable; and (4) the management structure for the program is adequate to manage and control unit-cost ("The National Defense Authorization Act for Fiscal Year 2010," 2009c).

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7 (Total Development Cost + Procurement Cost + Construction Cost) / (Total Program Quantity)
8 (Total Procurement Cost) / (Procurement Quantity)

### Reporting requirements that use NM breach thresholds

The breach thresholds established by the Nunn–McCurdy Amendment are recorded in several DoD-issued requirements, including the *SAR*, the Unit Cost Report (UCR), and the Acquisition Program Baseline (APB). The UCR fulfilled the DoD's obligation under NM to record additional unit-cost information. The UCR is primarily concerned with reporting unit-cost, schedule, or performance information that has occurred or is expected to occur (Land 2006). The APB is the DoD requirement to establish an official baseline for acquisition programs.

### Nunn–McCurdy Shortfalls

NM has been criticized for not fulfilling its purpose: to increase transparency into the defense acquisition system, thereby lowering the unit-cost-growth. Shortly after its passage, many government and private evaluations echoed the belief stated by Charles Bowsher, then-Comptroller General of the United States, that "(1) cost growth remains a serious problem—it is not under control after decades of recognition … and (2) overall, the cost-growth problem is as serious now as it ever was" (Bowsher, 1984). Overall, the acquisition difficulties that the DoD typically faced before the implementation of NM have persisted since the reporting mechanism was put into operation. The DoD continues to acquire systems that had higher cost, lower performance, and delayed schedules when compared to original estimates.

Congress believed the implementation of NM would solve three apparent problems with the acquisition system. First, the DoD did not provide enough information for Congress to properly manage the acquisition process. With more information, Congress would have been able to make better decisions. Second, the current process did not provide Congress and other oversight agencies with enough forewarning of impending acquisition problems. With an earlier warning, program managers (and, if need be, Congress) would have been able to intervene to solve small problems before the troubles escalated. Finally, the reporting system before NM provided few, if any, disincentives to discourage poor acquisition outcomes. Implementation of a significant deterrent effect—automatically shutting down an acquisition project unless Congress intervened—would have provided the DoD and private industry with sufficient reason to reform acquisition procedures to minimize the likelihood of program failure.

NM has not been able to solve these three perceived problems. First, although NM has provided Congress with more information, it has not necessarily furnished Congress with more useful information that has resulted in better acquisition outcomes. Second, Congress has not received more timely information since the implementation of NM. Most programs have avoided reporting unit-cost difficulties when rebaselining a program. Reestablishing the baseline does not require Congressional notification. For this reason, many believe that the DoD has abused the rebaselining practice, and, thus, they have not systemically reported unit-cost-growth to Congress (Axtell, 2006). Another concern is that although NM stated that the DoD should inform Congress when a program was expected to incur high unit-cost-growth, Congress is usually informed only once a unit-cost breach has occurred. By not providing timely information, Congress has been unable to take preemptive action. Third, NM did not provide a deterrent effect because few programs have incurred an NM breach, and those that do are "rarely … canceled outright under this provision … [because] Congress normally regards the explanations from the Secretary of Defense as acceptable" to reauthorize programs (Erwin 2008).

**Impact of original Nunn–McCurdy Amendment**

With the shortfalls of NM and the DoD's persistent acquisition troubles, it is difficult to assess the impact of NM on the performance of the acquisition process. Simply put, the same problems that oversight entities have with acquisition reporting data—information that is inaccurate, inconsistent, or unavailable—also hinder their ability to properly evaluate the usefulness of this data. Further complicating the matter, numerous acquisition reforms in a relatively short period of time make it difficult to determine the precise impact of any one reform effort. Therefore, even if NM did reduce program cost-growth (which is not incompatible with an increase in overall unit-cost-growth, spurred by other acquisition problems), it would be difficult to infer such a conclusion from the data available.

The relevant literature reflects the paucity of information regarding the impact of NM. To date, only one article that discusses the impact of NM on defense acquisition specifically has been published, although its focus is on defense acquisition reform more broadly. This article states that NM "had no affect on R&D cost overruns; but, holding all else constant was responsible for a 15 percent reduction of procurement cost overruns between 1982 and 1986" (Smirnoff & Hicks, 2008). The authors openly acknowledge, however, that their findings on the effect of acquisition process reforms in aggregate run broadly counter to the findings of other papers. Most authors argue that "despite the implementation of more than two dozen regulatory and administration initiatives, there has been no substantial improvement in the cost performance of defense programs for more than 30 years" (Christensen, Searle, & Vickery, 1999). To date, no published papers discussing the sole impact of NM breach requirements on the defense acquisition process have been found.

### The Packard Commission and the Goldwater–Nichols Act of 1986

Dissatisfied with continual defense acquisition problems, President Reagan established the President's Blue Ribbon Commission on Defense (also known as the Packard Commission) to study and make recommendations on DoD operations and management. The Commission issued its findings in 1986. Congress implemented many of the Packard Commission's recommendations in an expansive DoD reform bill known as the Goldwater–Nichols Act of 1986.

### Acquisition Program Baseline

One new requirement the Goldwater–Nichols Act implemented was the need for MDAPs to "document program goals prior to program initiation" (Land, 2006). The Acquisition Program Baseline (APB) fulfills this mandate. The APB includes objective and threshold values for program parameters—including cost, schedule, and performance—that the program manager is then expected to meet over the course of the project. If a deviation from the APB occurs, then the program has 90 days to (1) realign the program within the original APB parameters, (2) approve a new APB that changes the individual parameters affected, or (3) conduct a review for a more extensive APB reform. If none of these solutions has occurred, then a formal program review is to take place (Land, 2006). The purpose of the APB is to have a clearly defined baseline to compare the actual development of a project with the projected development. If a proper APB is established for a project with a relatively short time horizon, then there should be minimal differences between the prediction and outcome.

### 2006 Revision of the Nunn–McCurdy Amendment

From the time it was passed until 2006, the Nunn–McCurdy statute was essentially unaltered. Displeased with acquisition results, Congress added a new provision to the statute in the Fiscal Year 2006 National Defense Authorization Act that was signed into law in January 2006. As noted above, NM was criticized as ineffective in part because programs would usually rebaseline to avoid an NM breach. This loophole existed because the NM statute only considers unit-cost-growth over the current baseline estimate. Congress specifically addressed this loophole in its 2006 revision of NM by adding a second condition for incurring an NM breach: unit-cost-growth over the original baseline estimate. A significant unit-cost breach occurs when cost-growth exceeds 30% of the original baseline and a critical unit-cost breach occurs when cost-growth exceeds 50% of the original baseline estimate. The revision did not change the reporting requirements for either the significant or critical unit-cost breach.

Figure 5 outlines the current defense acquisition reporting requirements related to NM.

| Program Cost Breach Parameters | | | |
|---|---|---|---|
| | Applicable to Major Defense Acquisition Projects (MDAPs) | | |
| Reporting Requirement | Selected Acquisition Report (SAR) (Title 10. US Code Sec 2432) | Unit Cost Report (UCR) (Title 10. US Code Sec 2433) | Acquisition Program Baseline (APB) (Title 10. US Code Sec 2435) |
| Cost | 15/30% PAUC growth (Current/Original) 15/30% APUC growth (Current/Original) | 15/30% PAUC growth (Current/Original). 15/30% APUC growth (Current/Original) | 15/30% PAUC growth (Current/Original). 15/30% APUC growth (Current/Original). RDT&E, Procurement, construction or O&M growth above predetermined level (10% default, MDA discretion) |
| Reports Required if Breach Occurs | Quarterly SAR | Quarterly/Exception DAES. Service notifies Congress (>=15/30%). SecDef Certification (>=25/50%). | Program Deviation Report (PM notifies MDA) |
| PAUC: Program acquisition unit cost. APUC: Average procurement unit cost. | | | |
| Significant Cost Growth (APB/SAR/UCR): PAUC or APUC increases of 15% of current baseline or 30% of original baseline reported to Congress. | | | |
| Critical Cost Growth (APB/SAR/UCR): PAUC or APUC increases of 25% of current baseline or 50% of original baseline requires Sec Def certification to Congress that (1) the program is essential to national defense, (2) no alternative exists, (3) costs are under control, and (4) management is in place to keep costs under control. | | | |

**Figure 5: Program Cost and Schedule Breach Parameters**
Source: (Land, 2006).

**Impact of 2006 Nunn–McCurdy Amendment Revision**

Between 2000 and 2004, the *SAR* Summary Tables reported six programs as having experienced a Nunn–McCurdy unit-cost breach. In September 2001, the Navy Area Wide Theater Ballistic Missile Defense program became the first program to be terminated for a Nunn–McCurdy breach (U.S. Department of Defense Office of the Assistant Secretary of Defense (Public Affairs), 2002). In 2005, the DoD reported that 40 of the 85 MDAPs reported by the *SAR* Summary Tables experienced unit-cost-growth high enough to warrant a Nunn–McCurdy breach. Although 25 of these programs experienced over 50% unit-cost-growth over their original baseline, the DoD did not report programs as having incurred a Nunn–McCurdy breach because the National Defense Authorization Act permitted the "original baseline estimate to be revised to the current baseline estimate as of January 6, 2006" (Office of the Under Secretary of Defense (Acquisition Resources and Analysis), 2006). In the two subsequent years, 2006 and 2007, the *SAR* Summary Tables cited 16 programs for incurring unit-cost-growth in excess of 15%, although not all were necessarily reported to have experienced unit-cost breaches. Moreover, a number of programs that had unit-cost-growth in excess of 15% in 2005—some that breached and some that were rebaselined—would breach in 2006 or 2007. These programs included Guided Multiple Launch Rocket System (GLMRS), C-130 Avionics Modernization Program (C-130 AMP), Chemical Demilitarization (Chemical Materials Agency, Chemical Demilitarization CMA), Expeditionary Fighting Vehicle (EFV), Joint Air-to-Surface Standoff Missile (JASSM), and Joint Primary Aircraft Training System (JPATS) (Office of the Under Secretary of Defense (Acquisition Resources and Analysis), 2007, 2008). Appendix I lists all programs that reported unit-cost-growth or a Nunn–McCurdy breach between the years 1998 and 2008.

By eliminating the rebaselining loophole, the new NM statute has, at the minimum, made it clearer to observers of the defense acquisition process that many acquisition projects have not been developed within their original program estimates. The sheer number of programs that have experienced significant development difficulties indicates systemic problems with the defense acquisition process. If not targeted and corrected, then there is little reason to believe that future development results will differ substantially from poor outcomes experienced in the past.

What is less clear, however, is whether the revised NM has provoked a fundamental enough change in acquisition efforts to improve transparency and, subsequently, acquisition outcomes.  Currently, not enough time has elapsed, nor has enough data been collected, to determine if (1) programs that do incur an NM unit-cost breach are more likely to follow a sustainable path than were programs that breached prior to the NM revision, or (2) new programs have started on an initially more sustainable development path than programs started in years prior.  Although current acquisition difficulties remain high, the longevity of programs that comprise the existing acquisition portfolio means that even if the NM revision has produced positive change, improved results will likely take several years to identify.  At present, the most immediate short-term impact of the new legislation has been to provide greater visibility as well as a great deal more emphasis on the unit-cost-growth, relative to the original program baseline.

**2009 Nunn–McCurdy Legislation**

The Major Weapons Systems Acquisition Reform Act of 2009, signed into law in May 2009, made several additional revisions to improve the “organization and procedures of the Department of Defense for the acquisition of major weapon systems” ("Weapon Systems Acquisition Reform Act of 2009," 2009).  The statute established several DoD Directors with responsibilities over specific portions of the Research, Development, Test & Evaluation process as well as enhanced the use of cost estimates.  Additionally, Section 204 of the act specifically amended the Nunn–McCurdy Act, including adding two requirements to the process of recertifying programs that incur an NM breach.  A program with an NM breach now must (a) rescind the most recent Milestone approval and (b) receive a new Milestone approval before any actions regarding the contract may continue.  The new Milestone approval requires a certification that the costs of the program are reasonable, and the certification must be supported by an independent cost estimate that includes a confidence level for the estimate ("Weapon Systems Acquisition Reform Act of 2009," 2009).  This statute was implemented too recently to evaluate its impact upon the defense acquisition process.

# IV. Data Analysis

We conducted a data analysis using the information provided by the *Selected Acquisition Report* Summary Table for December 2007 (the most recent full-year set of data available when the study began).[9] The *SAR* Summary Table can be found in Appendix II. Because only a single *SAR* Summary Table was used, the information reflects a snapshot in time of DoD acquisition efforts. Although there is the possibility that the data do not represent the typical cross-section of the DoD's acquisition efforts, significant differences are unlikely because the MDAP profile typically does not change substantially over short periods of time. As part of our analysis, we conducted tests of independence on six groups of contingency tables.

The purpose of this analysis was to (a) highlight the limitations of *SAR* data for determining the root causes of cost-growth and (b) make limited inferences based on the available information.

In the data analysis, we computed several tests of independence using Fisher's *exact test*. Fisher's exact test is useful for calculating the exact probability of a given outcome when a small sample size exists.[10] More specifically, Fisher's exact test determines the "probability of getting a table as strong as the observed or stronger simply due to the chance of sampling" (Garson, 2008). The interpretation of the test's $p$-value $0.0x$ is that there is an $x$% chance that given the information provided in the contingency table, one would randomly draw an outcome as strong or stronger than the sample provided. As with a chi-square test of independence, the 95% confidence level is used to determine if a test result is statistically significant.

In the following results, we used the null hypothesis that there is no relationship between NM breach and the other variable. The alternative hypothesis was a form of the statement, "a relationship exists between NM breach and variable $x$." Only programs in

9 The other reporting mechanisms for unit-cost, APB and UCR, are not publicly available. As a result, the SAR Summary Tables were the only source used to determine whether a program had incurred an NM breach.
10 A chi-square test of independence would have been inappropriate because it is an approximation of the independence calculation, which is not accurate for small sample sizes.

development three years or longer as of the December 2007 *SAR* were included in the analysis, so as to avoid including programs too new to have developed significant development difficulties. Prior *SAR* Summary Tables were consulted to determine whether a program had incurred an NM breach. The December 2007 *SAR* Summary Table lists 71 programs that were in development for at least three years.

We conducted two sets of analyses. The first set of analysis counted a program as having breached if, and only if, an *SAR* Summary Table specifically stated that a program breached. More specifically, this analysis excluded the 25 programs that reported 50% unit-cost-growth or more in 2005 but were rebaselined to avoid an NM breach—unless the program incurred an NM breach at some other point in time. The second set of data designated programs as having incurred an NM breach if an *SAR* Summary Table stated either (a) the program had breached or (b) the program would have breached if not rebaselined. Programs that established new *original* baselines following the 2006 revision of NM (more specifically, the F-22 Raptor and Warfighter Information Network-tactical) were classified as too recent to be analyzed because the current *SAR* Summary Tables do not provide the information necessary to ensure that those programs were tracked consistently across time. More precisely, it would have been very difficult to determine what changes in cost took place due to differences in performance expectations between the two original baselines without additional information. If a program had incurred more than one NM breach, then the highest breach was recorded.

The first set contains 18 programs that experienced an NM breach at some point during development, whereas the second set contains 31 programs that recorded unit-cost-growth high enough to warrant an NM breach. All Fisher's exact tests are considered as statistically significant unless otherwise indicated.

We acknowledge that Fisher's exact test only offered limited insight into the data - a simple determination of whether two conditions are likely to be independent of one another. At best, one would be able to assert that two categories are correlated with one another. Such correlation, however, does not imply causation. Nonetheless, the authors have attempted to make informed inferences based on the information available.

**First Set**

The first set analyzes 18 of the 71 programs that have incurred an NM breach at some point during development.

For the first analysis, we included a corresponding contingency table in the data analysis section. Thereafter, corresponding contingency tables can be found in Appendix III.

**Breach by Service**

There appear to be large differences in the likelihood of breach as determined by Service, shown in Figure 6 (and reproduced in Figure 11). Whereas only 3 out of 28 Navy programs experienced a breach (11%), 4 out of 8 DoD programs did so (50%). Fisher's exact test produced a one-sided p-value of 0.001, which is statistically significant at the 5% confidence level. Put another way, there is only a 0.1% chance that one would randomly draw an outcome as strong as or stronger than the sample provided, given the information provided. Therefore, it is unlikely that this outcome happened due to chance alone. It appears that discernable differences exist in project development across the Services. From the information provided, one can infer that in 2007, the Navy performed better than average, whereas the Army was average and the Air Force and the DoD were above average (i.e., had significantly inferior performance), although this analysis does not clarify the root cause of why such differences may exist.

| | Breach | No breach | Total |
|---|---|---|---|
| Army | 3 | 9 | 12 |
| Navy | 3 | 25 | 28 |
| Air Force | 8 | 15 | 23 |
| DoD | 4 | 4 | 8 |
| Total | 18 | 53 | 71 |

P-value: 0.001

**Figure 6: Small NM group, NM breach by service**

**Breach by Quantity Change**

There also appear to be wide disparities in the likelihood of breach, depending on whether a project changes the quantity of units to be purchased. Out of the 25 programs that did not alter quantity, only 2 breached. While only 4 out of 21 programs that increased quantity incurred a breach, 12 out of the 13 programs that decreased quantity experienced a breach. The one-sided p-value was 0.000, indicating that there was less than 0.0% probability that this sample was randomly drawn. Although the *SAR* Summary Tables adjust the cost of the program for changes in quantity, those that decrease quantity appear much more likely to breach. One possible interpretation is that the unit-cost change equation is biased against programs with small quantities, although later analysis undermines the likelihood of this explanation. Alternatively, the correlation may indicate that programs that experience an NM breach are either more likely to reduce quantity in order to stay within program unit-cost thresholds or to reduce quantity after incurring a breach. As a result, it appears that cost-growth is the cause of quantity reduction rather than the result (see Appendix III, Figure 12).

**Breach by Baseline Value Size of Program**

Another important factor regarding the likelihood of breach may be the value size of a program. We converted programs into FY 2008 dollars to allow appropriate comparison. Using the baseline estimates, we broke up programs into three roughly equal categories: those under \$3.5 billion, those between \$3.5 billion–\$7.950 billion, and those above \$7.950 billion. Only 2 of the 21 programs under \$3.5 billion breached, whereas 16 of the 48 programs that were over \$3.5 billion breached. For this test, there was a 3.9% likelihood that the sample was randomly drawn. Breaking down the numbers further, 9 of the 24 programs between the values of \$3.5 billion–\$7.95 billion and 7 of the 24 programs valued at \$7.95 billion or more breached. This three-group sample had a 0.4% chance of being randomly drawn. Overall, it appears that those programs with lower initial values were less likely to breach than were programs that were more expensive at program initiation. The indication is that smaller programs have incurred less unit-cost-growth than larger programs, either due to better program management or more realistic estimates.

One possible explanation is that MDAPs with lower values are more likely to have the characteristics of successful acquisition program because they attempt to achieve only moderate improvements in performance over what is currently deployed, whereas larger programs that breach more often attempt to develop assets with revolutionary capability. For example, the C-130J, which has experienced no unit-cost-growth difficulties, is a modest modernization program that updates certain aspects of the C-130 aircraft, which has been in service since the 1950s. By contrast, the National Polar-orbiting Operational Environmental Satellite System, which has experienced an NM breach, is attempting to field capabilities that have never been proven operationally (see Appendix III, Figure 13).

**Breach by Current Value Size of Program**

A similar analysis of current estimates produced similar results. None of the 20 programs valued under $3.5 billion incurred a breach, whereas 18 of the 51 programs valued above $3.5 billion did breach. Because there was only a 0.2% likelihood that the distribution was random, one can reject the null hypothesis that breach and program size are independent. A breakdown of the large group into two categories (where 6 of 19 programs valued between $3.5 billion–$7.95 billion and 12 of the 20 programs valued at over $7.95 billion breached) revealed that this distribution has a likelihood of 0.4%. One skeptical interpretation would be that the information inaccurately conveys a correlation between low program value and no breach because programs that did encounter high unit-cost-growth would likely move into a higher program cost category. The programs valued at $3.5 billion or less, however, only shrank from 23 programs to 20 programs (albeit two breaching programs did change categories). That view is more valid at the highest value category, which appears to have picked up a number of programs that experienced high unit-cost-growth (this category expanded from 7 to 12 programs). Overall, it appears that the interpretation from the last assessment—smaller programs may have characteristics that lead their programs to breach less often—remains valid (see Appendix III, Figure 14.).

**Breach by (a) Average and (b) Median Cost of Program**

An analysis of breach against the (a) average cost of a project ($13.7 billion) and (b) the median cost of the project ($5.4 billion)[11] revealed surprising results. Of the programs below the average cost, 14 out of 58 breached (24%), whereas 4 out of 13 above the

11 Because the average cost exceeds the median cost, the data has a rightward skew.

average cost breached (31%). For the median, 6 out of 36 programs below the median cost breached (17%), while 12 out of 35 programs with values above the median cost breached (34%). Although a higher proportion of programs above the average and median values breached, the results were not statistically significant. These results were unexpected because the previous analysis showed a relationship between breach and the value size of a project. The simplest explanation is that the sample size was too small to prove statistical significance. One interpretation of the data could be that, on average, programs that breach have a high monetary value, but the largest programs do not breach because their initial values are large enough to preclude generating the unit-cost-growth necessary to breach (which would need to be, at the minimum, in the tens of billions of dollars; see Appendix III, Figure 15).

**Breach by Program Cost-growth Category**

The *SAR* Summary Tables list seven categories of cost-growth: economic, quantity, schedule, engineering, estimating, other, and support. Each cost category is meant to quantify different reasons for a change in the cost of a program over time. The economic category calculates inflation over time; the quantity category captures cost changes due to planned procurement of a different number of items; the schedule category assesses the impact of changes in the development timeline to cost; the engineering category evaluates changes due to modifications to the physical, or software, makeup of the product; the estimating category refers to updating prior assumptions about project or technological development; the support category refers to changes in costs not associated with the direct production of the item itself, but that are necessary to its functioning (such as spare parts or training); and the other category refers to all other items not addressed elsewhere, which requires approval by the Secretary of Defense, and includes events such as natural disasters (Harrison, 2007). However, as noted by a number of reports, "while there are guidelines on how to allocate cost-growth to these categories, the actual allocation is determined by each program” (Arena, Leonard, Murray, & Younossi, 2006). For example, if a program experiences technical difficulties that delay its deployment, then one program manager might allocate the cost to the estimating category; a different program manager might categorize the change under the schedule category; and a third program manager might assign it to engineering.  Overall, different reporting standards have lead to inconsistencies across the data profile, reducing the usefulness and accuracy of *SAR* data.

Two categories were excluded from our data analysis: economic and other.  The economic category only accounts for changes in inflation, which should only have a strong correlation with the length of time a program has been in development.  The *other* category was excluded because it is rarely used (only 5 programs from the data set recorded a non-zero number).

Programs were tabulated for each cost-change category depending on whether costs for the said category had increased, decreased, or remained unchanged during the development period of the project.  Only the estimating cost category did not include a cost unchanged category because every program experienced a change in that cost category.

All tests for independence between breach and each cost category were statistically significant.  As expected, each of the cost categories was correlated with unit-cost breach—cost-growth is necessary for an NM breach to occur.  Given that each cost category was correlated with breach, cost categories appear heavily interrelated.  From this, one can infer that programs that breach exhibit a relatively consistent pattern of characteristics.

As one would expect, positive cost-growth in the estimating category was correlated with breaching.  Based on changes in program estimates, only 1 out of 26 that had negative estimating-related cost-growth breached, while 17 of 45 that had positive estimating-related cost-growth breached.  The simplest interpretation is that programs that increase estimating costs are much more likely to breach than are programs that do not have to increase estimating costs.  Because the estimating-related category should only include changes due to initial estimating errors, the conclusion appears to be that in order to avoid development difficulties, programs should have sound initial estimates, which would minimize positive growth from estimates.

Our analysis of the quantity category produced unclear results. The data revealed that 11 out of 23 programs with negative quantity-related cost-growth breached, while 3 out of 23 with no quantity-related cost-growth breached, and 4 out of 25 with positive quantity-related cost-growth breached. One interpretation, as noted above, is that the correlation observed is likely to be the effect rather than the cause: significant positive quantity-related cost-growth leads programs to reduce cost, which often means reducing the amount of items procured. Another interpretation is that the NM requirement is biased against small-quantity programs because the quantity-adjustment calculation cannot fully compensate for a small-quantity program.

Data regarding the engineering category is similar to the data from the quantity category. Five out of 8 programs with negative engineering-related cost-growth breached; 3 out of 20 programs with no engineering-related cost-growth breached; and 10 out of 33 programs with positive engineering-related cost-growth breached. Although programs with negative and positive cost-growth are more likely to breach than programs with no cost-growth, the interpretation for why the positive and negative cost-growth groups are more likely to experience breach probably differs substantially. Programs with negative cost-growth are likely an effect of other cost-growth—put another way, a program likely experienced cost-growth resulting in an NM breach, and then reduced capabilities to reduce overall cost. In contrast, programs with positive engineering-related cost-growth that breach are more likely to be the cause of cost-growth—new capabilities were added to a project that have resulted in higher-than-expected cost-growth. This later explanation is often described as "requirements creep."

For the schedule category, 5 out of 14 programs with negative schedule-related cost-growth breached; 0 of 19 projects with no schedule-related cost-growth breached; and 13 out of 38 systems with positive schedule-related cost-growth breached. It appears that programs that change schedule are more likely to breach than programs that do not change schedule. It is unlikely, however, that programs with positive schedule-related cost-growth breached for the same reasons that programs with negative schedule-related cost-growth breached. The first group of programs was likely to experience an NM breach because programs fall behind schedule, leading to the incursion of substantial costs for the delay, such as additional pay to employees. Conversely, the second group of programs is likely to breach because the development schedule is accelerated—forcing the program to accept additional risk in order to make quicker deadlines. An alternative explanation would simply be that the correlation between schedule and breach may only indicate a correlation between length of program and likelihood of breach—programs that breach likely faced development difficulties, necessitating a change in schedule.

Data for the support category was skewed towards positive growth. While only 2 out of 21 programs with negative support-related cost-growth and 3 out of 15 with no support-related cost-growth breached, 13 out of 35 with positive cost-growth breached. A straightforward interpretation is that programs have been poor at estimating the true support costs they require. Another explanation is that this category is of limited usefulness because the definition of support costs often changes over the course of a project. For example, some items not included in initial estimates—such as ammunition for a weapon—may be included in the support category estimate only at a late development point, driving the unit-cost of the program up even if the program has not experienced development difficulties (see Appendix III, Figure 16).

**Breach by Largest Program Cost-growth Category**

A final analysis involved tabulating breach by the program's largest *SAR* cost category. The largest *SAR* cost category was calculated in two separate ways: (a) overall cost-growth, in which a program's largest *SAR* cost category was determined by the *SAR* cost category with the largest percentage of cost change that was positive; and (b) absolute cost change, in which a program's largest *SAR* cost category was determined by the *SAR* cost category with the largest percentage of cost change, regardless of sign. This method of calculation means that a program that is classified as the largest in one cost category for overall cost-growth may be categorized differently when measured by absolute cost-growth. For example, the Advanced Medium-Range Air-to-Air Missile (AMRAAM) was classified in the engineering category for overall cost-growth (6.60%) but was classified in the quantity category for absolute cost change (-8.10%).

In both contingency tables the three largest categories, which comprised the vast majority of programs, were estimating (25 overall, 34 absolute), quantity (19 overall, 22 absolute), and then engineering (17 overall, 10 absolute). The estimating-related cost-growth category accounted for 35% of the programs in the largest cost category and 48% of the programs in the largest absolute cost category. Moreover, the estimating and quantity categories combined accounted for 67% and 72% of the programs that breached for the respective groups. A Fisher's exact test analysis comparing the categories to breach shows that there is only a 0.1% chance that the largest cost category results were due to chance and only a 0.2% likelihood that the largest absolute cost category was due to chance. The implication from this analysis is that the estimating category appears to be the most important factor in determining which programs are likely to breach—not only because of its own importance, but as noted above, the quantity cost category is likely to reflect an effect of unit-cost-growth rather than a cause (see Appendix III, Figure 17).

**Second Set**

The second set analyzes the same dataset as was used in the first analysis, but codes 31 programs as having experienced high unit-cost-growth at some point in development. More specifically, this analysis considers programs to have experienced high unit-cost-growth if (a) the program has incurred an NM breach (18 programs) or (b) the program would have incurred an NM breach in 2005 if the program had not been rebaselined to avoid this designation (13 programs).

**Breach by Service**

Analysis of breach by Service using the broader definition of breach shows that the Navy was, again, below average, whereas the Air Force and the DoD experienced average results. Most noticeably, the Army moved from average to the most above average (58% of programs breached). The indication remains that differences exist in project outcomes, with Navy programs continuing to experience less unit-cost-growth than the other Services. The other inference from the information is that programs that avoided an NM breach were not evenly distributed throughout the Services. For instance, 4 programs out of the Army's 9 MDAPs avoided an NM breach, whereas the DoD experienced no change in its reporting (see Appendix III, Figure 18).

**Breach by Quantity Change**

Analysis of breach by quantity reaffirms the trends seen in the smaller sample. When broken down by two categories, 54% of programs that changed quantity breached, whereas only 24% of programs with no quantity change breached. A full 81% of programs that breached experienced a change in quantity. Results become more distinguished when utilizing three quantity change categories. 76% of programs that decreased quantity breached, compared to 48% that breached in the smaller set. Together, these breaches represent 61% of all breaches. The quantity-decrease category continues to represent the largest number and highest rate of breach. The inference from this information is that quantity decrease is an important characteristic of programs that breach. Logically, this outcome makes most sense if a program reduces procurement levels in order to compensate for budget cuts, cost-growth, or other development difficulties (see Appendix III, Figure 19).

**Breach by Baseline Value Size of Program**

This analysis reinforced the finding from the first set of data that larger programs appear more likely to breach. Eleven of the 13 (85%) rebaselined programs not previously examined were larger than $3.5 billion, with 7 from the largest-size category. When included in the analysis, those programs over $3.5 billion in value breached 56% of the time, compared to 33% of the group that breached in the first sample. Rebaselining—whether intentional or not—prevented many high-value programs from technically breaching. This information reinforces the first set's conclusion that large projects appear to be more likely to face development difficulties (see Appendix III, Figure 20).

**Breach by Current Value Size of Program**

The results of this Fisher's exact test mirror the outcome of the analysis of the breach by baseline value size of program. Programs valued over $7.95 billion breached 38% in the first set, a ratio that increased to 69% in the second set. Contrary to prior analysis, however, 3 programs below $3.5 billion breached. Surprisingly, no programs between the values of $3.5 billion and $7.95 billion were rebaselined. The general interpretation is, again, the large programs are much more likely to breach than other programs. This interpretation is reinforced by the fact that relatively few programs changed categories, and hence the majority of large programs that breached were initially large (see Appendix III, Figure 21).

**Breach by (a) Average and (b) Median Cost of Program**

As with the prior analyses, the number of programs that breach and that are above the average or median values of the sample increased significantly once the rebaselined programs were included in the data as breached. Those programs above the average value breached 69% of the time, compared to only 31% in the initial set. Although this p-value was not statistically significant at the 5% confidence level, it was at the 10% confidence level. Similarly, programs above the median value breached 63% of the time, compared to only 35% in the first set. Inclusion of the rebaselined programs is consistent with the observation that rebaselined programs tended to be of higher value than the non-breach programs. Moreover, inclusion of these programs explains the apparent anomaly in the data from analysis of the first set: when all information is included, there is a strong relationship between size of program and likelihood of breach (see Appendix III, Figure 22).

**Breach by Program Cost-growth Category**

Trends in the first set of cost-growth categories are reinforced once the rebaselined programs are included. For the estimating-related cost category, 27 out of the 31 (87%) programs that breached experienced positive cost-growth. Out of all programs that had positive cost-growth from this category, 60% breached. For the quantity-related cost category, the most important demarcation was negative cost-growth. Of the programs that recorded negative cost-growth, 78% also had an NM breach, up from 48% from the first set. The engineering, schedule, and support categories each showed stronger correlations between positive cost-growth and breach. When compared to positive cost-growth from the first set, each cost category increased at least 25 percentage points.

While not surprising, those with positive cost-growth (negative in the case of the quantity category) were more likely to breach than were programs that did not have positive cost-growth. The important finding of this analysis, however, may be that all cost-growth categories analyzed were statistically significant. This high correlation between breach and cost-growth categories implies either (a) systemic development problems in the acquisition system—programs that breach are different from programs that do not for numerous reasons—or (b) there is so much correlation between variables that the *SAR* does not provide useful information for uncovering the root cause of unit-cost-growth (see Appendix III, Figure 23).

### Breach by Largest Program Cost-growth Category

The final analysis involved tabulating breach by the largest program cost category, in both overall and absolute terms. As found above, the estimating and quantity change categories are the two most important categories related to cost-growth. Given prior inferences regarding quantity—namely that the correlation between breach and the quantity category's negative cost-growth is likely an effect rather than a cause—estimating appears to be the most important cost category and deserves intense scrutiny (see Appendix III, Figure 24).

### Data Analysis Conclusion

This analysis arrived at two conclusions. First, understanding the limits of the analysis, the authors have sought to interpret the information available. The most definitive statement that can be made is that programs that experience high unit-cost-growth do not appear to be randomly distributed. Going further, programs that breach appear to have the strongest relationship with three factors: the total dollar size of a project, the quantity change cost category, and the estimating cost changes. Programs appear much more likely to breach if the program has a high value (above $7.95 billion), positive estimating-related cost increases, or a change in procurement quantity. Conversely, programs with low value (below $3.5 billion), negative estimating-related cost-growth, or no quantity change appear to rarely breach. Second, the limited amount of publicly available data has precluded extensive statistical analysis. Much of the data collected now does not help decision-makers determine why a breach or unit-cost-growth has occurred or what programmatic changes would improve performance.  Although this analysis tested every metric provided by the *SAR* Summary Table (and most were found to be statistically significant), the information has not furnished the readers with much greater insight.  The available information makes it difficult to assert any conclusions definitively because all factors appear interrelated, which means that an unconsidered exogenous variable may be confounding all conclusions.

# V. Case Studies

### Space-Based Infrared System (SBIRS)─High

The Air Force's Space-Based Infrared System–High (SBRIS–High) is currently a $12 billion satellite program to detect and track missiles launched from foreign territory. SBIRS–High was originally designed to perform four missions: "missile warning, missile defense, technical intelligence, and battlespace characterization (observing and reporting on military activities on a battlefield)" (Smith, 2006). SBIRS–High is one part of the system-of-systems Space-Based Infrared System (SBIRS), which is one portion of the Missile Defense Agency's multilayered anti-ballistic missile defense system.

**Figure 7: SBIRS–High**

A Lockheed Martin–Northrop Grumman team was awarded the original contract for the entire SBIRS project in 1996, a contract valued at $2.16 billion (Smith, 2006). In 2001, the SBIRS–Low portion was transferred from the Air Force to the Missile Defense Agency, and in 2002, SBIRS–Low was renamed the Space Tracking and Surveillance System. As of 2009, the SBIRS–High program has spent $9.56 billion (in 1996 dollars); Lockheed Martin expects the first satellite to deploy at the beginning of fiscal year 2011 (Lockheed Martin, 2009).

**History**

SBIRS was designed to replace the current early-warning system known as the Defense Support Program (DSP). DSP was originally designed in the 1950s, and it has been in continuous service since the launch of the first satellite in 1970. According to one report, prior to SBIRS, "none of the proposed replacement programs—the Advanced Warning System in the early 1980s, the Boost Surveillance and Tracking System in the late 1980s, the Follow-on Early Warning System in the early 1990s, and the Alert, Locate and Report Missiles System in the mid-1990s—reached fruition" (Smith, 2006). In order to fulfill required capabilities in the meantime, the Air Force incrementally improved the existing DSP. Acknowledging that marginal improvements of the legacy system would not fulfill future requirements, the Air Force authorized another replacement program, SBIRS.

The SBIRS program has continually faced significant development difficulties. As stated bluntly by the GAO, "since its inception, SBIRS has been burdened by underestimated software and technical complexities, poor oversight, and other problems that have resulted in cost overruns and years in schedule delays" (Chaplain, 2007). In 2001, SBIRS incurred a critical NM breach because a preliminary cost analysis projected cost-growth in excess of $2 billion—approximately a 70% increase in unit-cost (Government Accountability Office, 2003). Congress certified SBIRS, and the program was restructured in 2002. Under its new plan, the program's budget increased to $4.4 billion and its deployment was delayed from 2002 to 2004. Despite its recent restructuring, the GAO noted "it has become increasingly evident that the underlying factors that led to the Nunn-McCurdy breach—particularly the lack of critical knowledge—continue to cause problems, and additional cost and schedule slips beyond the revised acquisition program baseline appear inevitable" (Government Accountability Office, 2003). As predicted, development problems persisted. In 2005, SBIRS was one of the programs experiencing unit-cost-growth in excess of 50% of its current baseline, and, as a result, the DoD rebaselined the program before the 2006 revision of the Nunn–McCurdy amendment took effect.

**Alternative Infrared Satellite System**

In 2005, the DoD instructed the Air Force to develop an alternative to SBIRS–High following the program's restructuring to avoid an NM breach. Full development of the program, known as the Alternative Infrared Satellite System (AIRSS), began in 2006. AIRSS was principally designed to compete with SBIRS–High to ensure that the United States maintained a vital missile warning capability if the SBIRS–High program faced more setbacks. AIRSS was also designed, however, to potentially provide more advanced capabilities than SBIRS–High, if the rescheduled SBIRS–High program appeared to be on a sustainable development track. The GAO noted the apparent incompatibility between these two goals (i.e., the short development timeframe and the higher performance) and further asserted that it "became evident that AIRSS could not realistically serve as a back-up to SBIRS(–High) because the proposed satellite delivery schedule is very aggressive for meeting the 2015 launch availability date, according to AIRSS program officials" (Chaplain, 2007). This development path is particularly concerning because SBIRS–High has continued to face difficulties, leaving the military without the option to quickly replace its aging satellites in service, if they were to fail.

**Recent SBIRS–High Progress**

In January 2007, the program experienced another major setback when the flight software for the first satellite failed testing. This setback was expected to delay the program by 15 months and cost $414 million. The GAO, however, judged that neither its own internal assessment "nor the independent reviewers who examined the redesign approach indicated that the current goals were executable," because expectations were too optimistic (Government Accountability Office, 2008). The GAO's most recent assessment of the program noted that problems continue, as only “two of the SBIRS High program’s three critical technologies are mature—a lower level of maturity than last year” (Government Accountability Office, 2009). At present, Lockheed Martin expects the first satellite to deploy at the beginning of fiscal year 2011 (Lockheed Martin, 2009).

**Lesson Learned**

The Space-Based Infrared System (SBIRS)–High program highlights how the threat of an NM breach does not necessarily lead to improved acquisition outcomes because many programs that incur an NM breach continue to face acquisition difficulties throughout their development cycle. Although many programs must be restructured, in most cases they cannot be established upon a sustainable development path. Problems that plague programs at initiation, such as optimistic expectations using immature technologies, are difficult to fix once the program is midway through its development. Although NM may be effective at alerting Congress of problems in system development, it is unlikely to provide Congress an effective opportunity to prevent or avoid the majority of unit-cost-growth without broader reform.

# Virginia-Class Submarine (SSN-774)

The Virginia-class submarine is the Navy's newest class of attack submarine. The Navy initiated development of this craft in 1993 to replace attack submarines designed during the Cold War. The goal of the program was to produce a ship that was low cost and highly versatile. The submarine program experienced unit-cost-growth issues that culminated in a significant Nunn–McCurdy breach in December 2005. Since that point in time, the Navy has made a concerted effort to reduce costs. As of late 2009, the Navy has been at least partially successful in reducing the costs of this project, although the full impact of recent policy changes will take a few years to determine.

**Figure 8: SSN-774**
Source: (Northrop Grumman, n.d.)

**Description**

The Virginia-class submarine is the Navy's newest nuclear-powered attack submarine. The submarine is also known as the SSN-774 class.[12] The submarine was initially designed to be "a cheaper alternative to the Cold War era Seawolf-class [and older Los

12. *SS* denotes the ship as a submarine, while *N* is the classification for nuclear powered.

Angeles-class] attack submarines" (U.S. Navy Commander of Naval Submarine Forces, 2009).

Reflecting the DoD's post-Cold War assessment of military threats, the SSN-774 is designed to be flexible and to fulfill a versatile mission portfolio. Its missions include combat operations against enemy submarines and surface ships, precision sea-to-air strike capability (available due to use of Tomahawk cruise missiles), enhanced surveillance missions, and special operations support. The craft is design to engage enemies in both blue-water and littoral environments (Government Accountability Office 2009). To handle its various missions, the submarine is equipped with 12 vertical-launch system tubes, which fire Tomahawk missiles, and 4 torpedo tubes (Commander of Naval Submarine Forces U.S. Navy 2009).

The submarine class will gradually be equipped with three new, major submarine innovations: "advanced electromagnetic signature reduction, a flexible payload sail, and a conformal acoustic velocity sensor wide aperture array" (Government Accountability Office 2009). A Virginia-class submarine is able to reduce its signature significantly through the use of advanced software algorithms that automatically adjust to minimize signals that would alert sensors to the presence of the submarine, thus making the ship stealthier. The sail has a flexible payload that can house different payloads or systems, depending on the requirements of the mission. This area is now available for reconfiguration because the mast is fully electronic. Finally, the conformal, acoustic velocity sensor-wide aperture array is a sensor array that surrounds the submarine, giving it vastly improved sonar perception around the entire ship (Government Accountability Office 2009). The Virginia-class has also been designed (utilizing an "open architecture") to allow for the rapid insertion of new technologies as they become available.

An additional goal of the Virginia-class design is to significantly decrease lifecycle costs when compared to past submarines. Because the most important contributor to lifecycle costs is the crew, the Navy has sought to reduce the number of crew required to serve on the ship through greater automation of ship functions (Government Accountability Office, 2006).

### Other Acquisition Conditions

The Navy's design for the Virginia-class submarine took into consideration concerns other than the performance of the vehicle.  Three other objectives of the program were to (1) sustain the submarine attack fleet at approximately 55 ships (revised in 2006 to about 50 ships), (2) maintain the strategic capability of two shipyard facilities capable of producing nuclear submarines (General Dynamics' Electric Boat shipyard in Groton, Connecticut, and Northrop Grumman's Newport News shipyard in Newport News, Virginia), and (3) acquire the system at low cost.  In order to fulfill this last objective, the Navy needed to implement an effective acquisition plan to avoid the historically high-cost-growth associated with the lead ship of a new class.

As noted by the GAO, "there is tension inherent among the multiple objectives of the plan" (Government Accountability Office 2006).  Maintaining two shipyards capable of building nuclear-powered submarines with a low annual build rate is not cost effective in the short run (Ronald O'Rourke 2004).  While the two shipyards may exert enough competition to reduce Navy nuclear-submarine acquisition costs in the long term, the Navy must pay a high upfront price to keep open an option that may not yield predicted returns (especially if the current program does not compete them).

### Initial Development

The government initiated what would become the Virginia-class submarine development in 1991, with the explicit goal of producing a more versatile but less costly submarine than the most recently developed Cold War submarine, the Seawolf-class.  In early 1996, the Navy awarded a sole-source contract to Electric Boat for development of the detail design of the SSN-774 program.  This agreement was unusual because the Navy often bundles detail design with a commitment to construction, which commits the government to future procurement very early in the development process (Government Accountability Office 2005).

By the end of 1996, however, Electric Boat and Newport News Shipbuilding—the owners of the only two U.S. shipyards capable of building nuclear-powered submarines—“proposed to construct [the submarines] as a team, rather than as competitors” (Federation of American Scientists). Although the Navy estimated in a 1997 study that the joint-production arrangement would increase the cost of each submarine from about $1.55 billion to $1.65 billion in FY1995 dollars (plus or minus $50 million, depending on the number of submarines procured), this arrangement allowed both shipyards to remain active, in accordance with Congressional wishes (O’Rourke, 2004). In 1998, the Navy awarded the partnership a $4.2 billion contract for the construction of the first four ships of the Virginia-class submarine (Commander of Naval Submarine Forces U.S. Navy 2009).

**Integrated Product and Process Development (IPPD)**

The Virginia-class submarine was the first submarine designed by the Navy that used a new design process known as integrated product and process development (IPPD). The purpose of the process is to “reduce cost by streamlining the design and construction process” (John F. Schank, Mark V. Arena, Paul DeLuca, Jessie Riposo, Kimberly Curry, Todd Weeks, and James Chiesa. 2007). IPPD achieves this goal by undertaking the processes of the traditional design process concurrently. The process relies upon an integrated team that has participating members from all important constituents – designers, construction personnel, and the Navy – throughout the entire acquisition process. If implemented correctly, IPPD can result in more rapid design with fewer required changes than the traditional design process – as the SSN-774 program achieved in its design phase (Schank, Arena, DeLuca, Riposo, Curry, Weeks, & Chiesa, 2007).

**Initial Construction Contract**

The initial two-shipyard contract was a cost-plus-fixed-fee contract for four submarines, awarded in 1998. Due to significant risks in material costs, the contract included provisions to procure such materials as a special line item, with a separate cost-plus-fixed-fee agreement (Government Accountability Office, 2005).

The SSN-774 contract was unique because, for the first time, the Navy authorized two shipyards to construct a single nuclear submarine. Under the agreement, each shipyard is designated specific portions of the submarine to build. The shipyards then alternate responsibility for (1) building the reactor components of the submarine and (2) undertaking final assembly of the craft. Overall, the profits of the venture are to be split evenly between the two firms (Office of the Assistant Secretary of Defense (Public Affairs) U.S. Department of Defense 2003).

Contracts for the first ship of a class are typically structured as cost-plus. As noted by the GAO, the Navy tends to procure ships in this manner "because these ships tend to involve a high-level of uncertainty and, thus, high cost risks" (Government Accountability Office 2005). Historically, ship designs change substantially between the end of the design phase and the service of the first ship. Changes occur for a variety of reasons, including construction issues and the Navy's assessment of the performance of the ship during sea trials. Once a ship's design has stabilized, the Navy typically writes a fixed-price contract agreement.

**First Development Group**

In 1998, the construction of the lead ship, SSN-774, began at the Electric Boat shipyard. Construction of the second ship, the first produced at the Newport News shipyard, began in 1999. Escalating costs lead the Navy to request additional funds to complete the ships. By early 2003, the program was experiencing unit-cost overruns of 24%, prompting the program office to revise the baseline estimate in April 2003, avoiding a Nunn–McCurdy breach (Francis, 2003).

**Second Construction Contract**

Despite program difficulties, the Navy awarded the contractors with a multiyear contract for six additional submarines in August 2003.

Multiyear procurement authority allows the Navy to contract for purchases that will occur in future fiscal years. This contracting method allows for more efficient acquisition than can be achieved by renewing annual contracts because it allows contractors to plan ahead and acquire resources in a more economical manner. Although more economically efficient, Congress does not typically authorize such transactions because (1) such agreements mean that the present Congress obligates future Congresses to spend funds and (2) if a program is risky, this agreement commits the government to a costly long-term development process or requires the government to pay a substantial financial penalty to cancel the program (Francis, 2003). The Navy has estimated that multiyear contracting would save an average of $155 million per submarine (U.S. Department of Defense Office of the Assistant Secretary of Defense (Public Affairs), 2003).

The second contract has a relatively simple incentive structure. As noted by John J. Young, Jr., then Assistant Secretary of the Navy for Research, Development, and Acquisition, "the contract … increases industry's profitability [if they come in] below the target price, incentivizing them to control and under run the target. It shares the cost above the target, with industry taking a greater share of those costs [than] in many of our other shipbuilding contracts, thereby discouraging overruns to costs" (Office of the Assistant Secretary of Defense [Public Affairs] U.S. Department of Defense 2003). More specifically, the contract had a 12.5% profit for the first submarine and 12% for the other SSN-774s. If the contractor kept costs below 95% of the intended unit-cost goal, industry would keep 90% of the savings. Between 95–100% of the unit-cost target, the firms would keep 70% of the savings. If costs came in over the unit-cost target, however, the firms would be docked a percentage of their fee. For example, if costs exceeded 104% of the target unit-cost, then the firm would have to pay 55% of the cost overrun (Office of the Assistant Secretary of Defense [Public Affairs] U.S. Department of Defense 2003).

**Development Difficulties**

Despite rising unit-cost-growth, SSN-774 was delivered in October 2004, only four months behind schedule. At the same time, SSN 775 faced unit-cost-growth in excess of that experienced by the SSN-774. One of the principle reasons for this growth was that SSN 775—the lead ship at the Newport News shipyard—was contracted at a price that reflected a follow-on ship order. Thus, the SSN 775 was expected to reflect the benefits of a shipyard moving down the learning curve, even though the Newport News shipyard did not have prior Virginia-class construction experience.

The Virginia-class submarine program experienced a significant NM breach in December 2005. At that time, the program had unit-cost-growth of 34.8% over its original baseline (Office of the Under Secretary of Defense (Acquisition Resources and Analysis), 2006).

Subsequent government reports highlighted some of the reasons for the unit-cost-growth of the program. The primary cause of cost-growth was the low estimate for material and labor-hour costs that would be required to complete the two submarines under construction, the SSN-774 and SSN 775. The average source of cost-growth is shown in Figure 9.

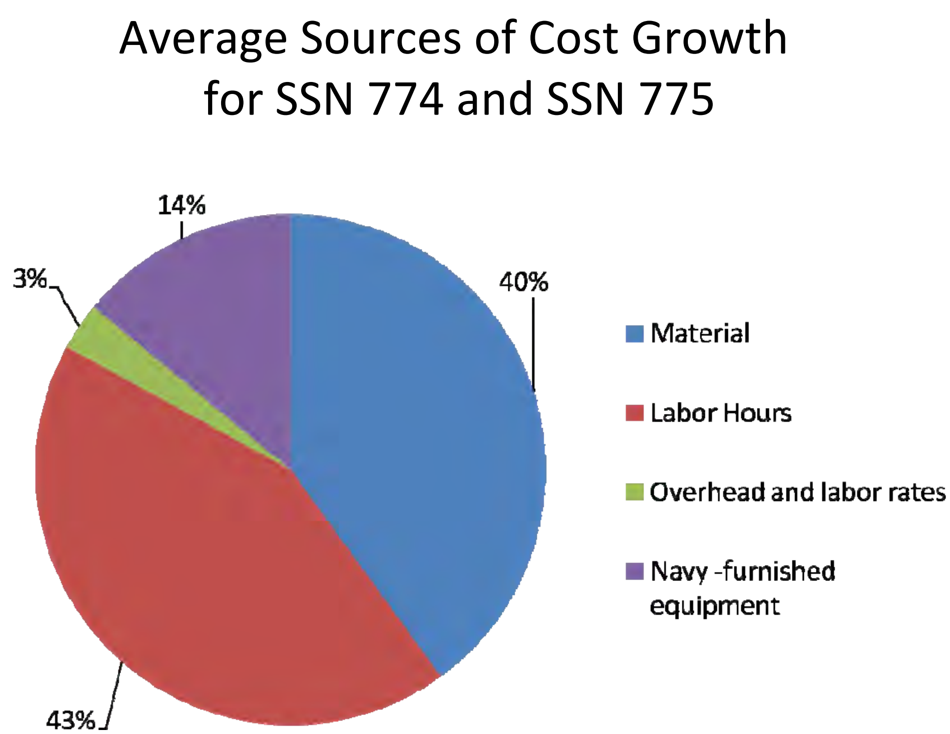


**Figure 9: Average sources of cost-growth for Virginia-class submarines**
Source: (Government Accountability Office 2005)

Several factors contributed to the low cost estimates. Initial estimates were unrealistically low because the Navy used optimistic design and technology assumptions in constructing its risk assessment of the program. Moreover, the program lacked a complete cost analysis. For instance, the cost analysis used the acquisition environment of the 1980s as the baseline for the analysis, even though such conditions had changed significantly by the late 1990s. Furthermore, the cost analysis lacked an independent assessment, or a confidence estimate. Finally, the cost-plus-fixed-fee contract contributed to the difficulties faced by the program because the firms agreed to “design and construct these ships for $748 million less than their estimated costs because the contract protected their financial risk” (Government Accountability Office 2005). By accepting the vast majority of the financial risk associated with cost-growth, as well as by providing the contractors with a large fee for their services, the Navy presented the contractors with a low-risk, but high-payoff opportunity. By contracting in this way, the Navy did not fully uphold its responsibility to properly estimate the program’s cost and, as a result, enhanced the program’s risk of failure.

Other factors posed obstacles to improving acquisition performance once development started. First, “about 80% of the total material procured from supplier firms for the construction of submarines (measured in dollars…) [came] from single or sole source suppliers” (O’Rourke, 2009). Purchasing from a single buyer typically occurred because only one supplier operated in a given niche market. Second, the Navy receives information on the program only once a quarter, delaying identification of problems and implementation of solutions. Third, the information the Navy collects is not sufficient to determine the real causes of cost-growth. This limited visibility makes it difficult to develop and implement effective solutions.

**Program Development to Present**

The Navy has grown increasingly concerned about the high unit-cost-growth of the Virginia-class submarine, prompting efforts to reduce the cost of the program in 2004. The specific goal of the present cost-reduction plan is to trim the cost of every submarine by $400 million dollars, from approximately $2.4 billion to $2.0 billion (in 2005 dollars) (Shalal-Esa, 2008). Achieving this goal is vital because without additional funding, the Navy will have to reduce planned procurement of the SSN-774 class.

To date, the Navy and contractor shipyards have realized some of the Navy's planned cost-reductions. Some of these cost-reductions would likely have occurred without additional Navy actions. For example, the contractors have now begun construction of follow-on ships, which have historically experienced lower cost-growth than lead ships. The shipyards have moved down the learning curve and have avoided problems that caused significant cost-growth in the construction of the lead ship. This greater knowledge has also produced other benefits, such as more effective use of multiyear contracting. Other cost savings have been generated through more direct action, mostly in design changes to reduce the acquisition cost of the submarine. The most important change was the decision to build the submarine in four sections, compared to the initial construction in ten sections. This change significantly reduced the time needed to build the submarine, which, in turn, substantially reduced labor costs. Other examples of cost savings can be found in the modification of the spherical sonar array and in the simplification of the vertical-launch missile tubes. Overall, the Navy expects to achieve a cost-reduction of approximately $200 million per ship—due to improved economies of scale—and the other $200 million from changes to the ship's design or shipyard production process (O'Rourke, 2009).

The Navy's cost savings plan has already achieved some results. In June 2008, the Navy christened the *New Hampshire*, which was "delivered eight months ahead of schedule and $54 million under budget" (Associated Press, 2008). One month earlier, Admiral Gary Roughead, Chief of Naval Operations, stated the following in Congressional testimony: "I consider Virginia Class cost-reduction efforts a model for all our ships, submarines, and aircraft" (Roughhead, 2009).

Partially due to the success of the *New Hampshire*, the Navy authorized the third contract for Virginia-class submarine construction in December 2008. This fixed-price, multiyear contract for eight submarines was valued at $14 billion. For the first time, the program contracted to build two submarines a year—one at each participating shipyard—starting in fiscal year 2011 (O'Rourke, 2009).

Most recently, Navy officials stated that the program has “reduced costs by more than $172 million per ship through design changes and construction time reductions," which the GAO believes places the program on track to achieve its goals (Government Accountability Office, 2009). It will be difficult to assess the validity of these estimates, however, until the submarines have entered service.

**Lessons Learned**

The Virginia-class submarine case study highlights how a program that has incurred an NM breach can implement policies to improve acquisition outcomes. The authors determined several lessons learned from this case study.

*The Nunn–McCurdy breach did not appear to be an important factor in provoking the Navy to implement cost-savings changes to the Virginia-class program.* The Navy's first cost-reduction efforts took place prior to the program's Nunn–McCurdy breach. While the Nunn–McCurdy unit-cost breach may have highlighted the need for, or the extent of, the eventual cost-reduction plan, it is difficult to determine the impact of the breach on the cost-reduction effort because few reports reference the unit-cost breach in relation to the cost-reduction effort. Although anecdotal, most reports on the matter highlight the Navy's fear that high unit-cost would reduce the number of submarines that could be acquired. Some reports went as far as to link the Navy’s cost-reduction objective—achieving a unit-cost of $2 billion—with the maximum unit-cost level that would allow the Navy to procure two submarines a year. Ultimately, it is difficult to determine which events triggered programmatic changes that have reduced acquisition and unit-costs, but it does not appear that the NM breach was a principle instigator.

*A proper business plan should include an independent cost analysis and use confidence levels to determine certainty.* An independent cost analysis would provide an objective assessment of the Navy-contractor estimate, while a confidence level would help define the risk associated with the project. The Navy's development plan for the SSN-774 did not include either of these measures. Congress has since mandated the use of these procedures in the Major Weapons Systems Acquisition Reform Act of 2009.

*The Navy should separate contracting for lead ships from contracts for follow-on ships.* By contracting for follow-on ships at the same time that it contracted for the lead ships, the Navy lost the opportunity to incorporate the knowledge gained through initial construction for future contract negotiations. Given that lead-ship construction typically incurs high cost-growth, the Navy has extra incentive to avoid committing itself to a process or program that might be more costly than it originally projected. Separating construction buys would also give the Navy and contractor additional time to determine how the process can be improved, helping to avoid cost-growth.

# VI. Findings

**Unit-cost-growth has remained high since NM was implemented in 1982.**

Based on our analysis of the studies presented above, we have determined that unit-cost-growth from the 1960s through the 1990s appears to have averaged at least 50% above initial cost estimates. The GAO estimates that the current MDAPs under development have experienced, on average, 26% program cost-growth, which will likely grow significantly by the time the systems are finally retired in future decades (Sullivan, 2008). This program cost-growth is likely to underestimate unit-cost-growth because programs typically reduce quantity in order to reign in a project's overall cost. Due to high and persistent program and unit-cost-growth, it is safe to assume that the acquisition process has significant challenges.

**Few programs incurred an NM breach until the recent 2006 revision of the law that requires programs to consider unit-cost-growth above the program's original baseline.**

Although unit-cost-growth has been high since the establishment of NM, few programs incurred an NM breach until the 2006 revision of the statute required programs to consider unit-cost-growth above a program's original baseline. At that point, 25 programs avoided an NM breach by rebaselining (under a "grandfather" clause). Although a significant number of programs have now incurred an NM breach (at least 26 programs), few programs have been cancelled due to NM.[13] Moreover, multiple sources argue that no programs have been cancelled solely for cost reasons, which may undermine the desired effect of NM (Erwin, 2008).

**Data Collection is Inconsistent.**

The DoD does not track acquisition information accurately or consistently across the entire department, nor is such information provided in a timely manner. Definitions and

13 Identifying programs cancelled due to an NM breach is difficult. After searching SAR summary reports from 1995–2007, we found that only two program cancellations occurred shortly after an NM breach or noted an NM breach as the cause for cancellation. These programs are the Navy Area Terminal Ballistic Missile Defense (2001) program and the Navy's Advanced SEAL Delivery System (2005).

baselines typically change multiple times over a program's development cycle. Data that is reported tends to be of marginal value. For example, the *SAR*'s eight high-level aggregated categories do not provide oversight officials with the knowledge required to make informed program decisions. Moreover, most reported information is input oriented, and, as a result, no linkage exists between data and the performance of a program. The existing data collection and information systems are not consistent with the kinds of information systems that world-class commercial firms employ.

**The DoD often has not conducted systematic analysis of root-cause problems.**

At present, the DoD does not systemically analyze its acquisition difficulties. Each program that incurs an NM breach is, in effect, treated as a separate incident that is unrelated to other programs that experience development difficulties and NM cost breaches. Given that the system has experienced significant difficulties over a prolonged period of time, it appears that systemic problems plague the acquisition system. Systemic problems require a more holistic view of the acquisition process in order to diagnose and treat it effectively.

**Limited and inconsistent data undermines an effective analysis.**

The limited available data does not allow for a definitive determination regarding the root cause of unit-cost-growth. Without such information, the DoD has been unable to diagnosis, treat, and, ultimately, cure systemic acquisition problems that have symptoms such as high cost-growth, schedule delay, and reduced system performance.

Moreover, as a result of the limited data, no consensus exists regarding the impact of NM on unit-cost-growth. While one report stated that NM appeared to reduce procurement unit-cost-growth, other researchers concluded that acquisition reforms as a whole had little to no impact on unit-cost-growth. Given persistently high unit-cost-growth, it is unlikely that NM significantly reduced unit-cost-growth.

Available data only allowed for a limited data analysis. This analysis revealed that a number of simple factors (such as program size or quantity change) appear to be related to an NM breach. Although it appears that projects that incurred an NM breach tend to have similar characteristics, the lack of more useful information precludes an analysis that would yield more useful conclusions.

**NM may identify acquisition problems too late in the development process to allow program reforms to be effective.**

There are many individuals responsible for the performance of the DoD's acquisition programs, including individual program managers, the applicable program executive officer, the USD(AT&L), and, ultimately, the Secretary of Defense. The people in these positions generally have the greatest insight into a program's status and problems. However, since the DoD's record in controlling cost-growth for major programs has, in general, been poor, Congress has taken proactive measures in an effort to control cost-growth, including legislating the Nunn–McCurdy Amendment.

But, as currently implemented, NM may report problems to Congress too late to allow a program to implement meaningful reform and avoid excessive unit-cost-growth. Although NM specifically states that Congress should be notified if a program manager believes that acquisition difficulties may occur, often Congress is not informed of a program's unit-cost-growth until an NM unit-cost breach is imminent, or has actually taken place. Current practice not only diminishes the ability of Congress to appropriately fulfill their oversight role, but also reduces the deterrent effect of NM. Furthermore, by the time a program manger reports that a program is incurring unit-cost-growth great enough to warrant an NM breach, the program is likely to be too far along its development path to avoid significant problems. The earlier that senior leaders and oversight activities are alerted to a program difficulty projected to significantly impact cost, performance, or schedule, the sooner decision-makers can implement necessary program changes.

**NM's effectiveness may be limited by its focus on the development and procurement of assets as opposed to the entire lifecycle of the program.**

NM focuses on unit-cost-growth during the RDT&E and production phases of system acquisition. Although these phases represent a significant portion of a system's ultimate cost—approximately 50%—NM does not cover the operations and support phase that represents the other 50% of a typical weapon system's cost. Without tracking and enforcing lifecycle cost-growth, the DoD cannot properly manage its assets and make important long-term strategic tradeoffs. For example, program managers may reduce development cost to avoid an NM breach, but these actions may ultimately significantly increase the system lifecycle costs (such as through reduced reliability).

**Recent legislation has not been implemented long enough to evaluate its impact on DoD acquisition processes.**

The legislations that took effect in 2006 and 2009 have not yet been in place long enough to evaluate their impact. A proper evaluation will require several years of data in order to determine if the legislation had the effect that legislators sought. Evaluation will be especially difficult because most programs have already been in development for an extended period of time, and the sample size is small. A brief qualitative assessment of the legislation is that the reforms addressed three major NM loopholes. First, the 2006 revision limited the ability of programs to avoid NM breaches through rebaselining—although the new breach criteria are set rather high. Second, the 2009 revision expanded the use of effective cost-estimating techniques. More specifically, the statute now requires that a program utilize independent cost estimates and estimate the risk of the program.

These techniques should improve the utility of cost estimates by increasing the accuracy and verities of such estimates, in turn helping programs to start on a sustainable development path. Finally, the legislation mandates that program managers perform an analysis—known as the Performance Assessment & Root Cause Analysis (PARCA)—to determine the reasoning behind a program breach. Congressional intent in directing the establishment of this organization was to create a capability to identify and track a series of meaningful metrics about performance for DoD MDAP programs. If effectively implemented, PARCA could help the DoD to determine earlier programs that are facing problems as well as the factors most likely to cause a program to breach, thus helping to formulate more effective policy in the future. The long-term impact of this new legislation, however, cannot be fully assessed at this time.

# VII. Recommendations and Conclusion

### Recommendations to Improve Nunn–McCurdy

**The DoD should develop a system to determine and distribute lessons learned from NM breaches throughout the DoD.**

The Weapon Systems Acquisition Reform Act of 2009 mandates that programs that experience an NM breach undergo a Performance Assessment & Root Cause Analysis (PARCA) to determine why a unit-cost breach occurred. The DoD should take this policy one step further by mandating that these analyses be utilized to determine lessons learned that are applicable to, and distributed throughout, the DoD as a whole. In this way, the DoD can learn from its past mistakes and minimize the potential for similar mistakes to be made in the future.

**The DoD Should Develop Leading Indicators.**

The DoD should develop leading indicators to provide greater warning of unit-cost-growth difficulties. These measures would allow the DoD to better understand when a program has encountered development difficulties, and they would provide decision-makers—including senior DoD acquisition managers and, if required, Congress—with the opportunity to fulfill their oversight obligations. As a result, the DoD would have greater incentive to recognize and remedy development issues at an early stage of development, when such decisions can be fixed at the lowest cost.

The leading indicators should act as an anticipatory warning system. Like an NM breach, unit-cost-growth that exceeds a predetermined threshold should trigger enhanced reporting requirements to clarify why a problem has occurred and how the program manager plans to rectify the situation. In this way, program managers can identify problems before unit-cost-growth increases to the point at which an NM breach occurs. A favorable anticipatory warning threshold would likely be between 5–10% over a program's original estimate.

**Recommendations to Control Unit-cost-growth**

**The DoD should fully embrace and implement the Weapon Systems Acquisition Reform Act of 2009 legislation.**

Prior attempts to reform DoD acquisitions have generally been ineffective, in large part due to the DoD's institutional resistance. The Weapon Systems Acquisition Reform Act of 2009 attempts to address many of the persistent difficulties found within the defense acquisition system. Solutions include promotion of competition throughout the lifecycle, greater use of independent cost estimates and confidence intervals, new director positions to oversee the acquisition system, and new and more stringent procedures to recertify a program that has incurred an NM breach. This legislation will only be effective, however, if the DoD embraces the change. Prior attempts to reform the DoD have been ineffective in large part due to the DoD's institutional resistance. The DoD would reap significant returns by internalizing recent legislation in order to incrementally improve its own operations.

**The DoD should identify cost as a development requirement of equal importance to performance and schedule.**

All too often, the DoD sacrifices cost objectives in order to maintain a program's performance or schedule. Unfortunately, these decisions often do not consider what would represent the best-value tradeoff for the DoD. The DoD's emphasis on performance and, to a lesser degree, schedule persists because the DoD's culture emphasizes first and foremost having the most capable system, with much less consideration given to development and procurement costs. We believe that programs should have a unit-cost requirement, equal in priority to performance and schedule, to help define the appropriate trade-space for the program office. This would also promote cultural change, creating much greater sensitivity to the importance of program cost.

**The DoD should implement a more complete acquisition-data information system.**

A more comprehensive data information system is needed to provide oversight officials with the knowledge required to make effective programmatic decisions. The system should also make use of performance-based metrics in order to provide a link between acquisition progress and results. To that end, the *Selected Acquisition Report* system must be reformed and updated. The DoD should initiate this lengthy task by commissioning a task force to identify the best way to develop and implement a new acquisition reporting information system.

**The DoD should consider lifecycle costs when rendering acquisition decisions.**

At present, DoD program officials typically make decisions based on relatively short-term time horizons, and they often do not consider the impact of these on the lifecycle of the program. As a result, many of these decisions may be optimal in the short run, or for the current program phase, but suboptimal over the program's lifecycle.

With the current form of the NM legislation, no consideration is given to a program's lifecycle cost. One can envision a situation in which development or procurement changes that would significantly reduce lifecycle costs are avoided to preclude an NM breach. In order to avoid unnecessary future costs, the DoD should mandate that program officials consider the lifecycle impact of alternatives before the decisions are made.

**The DoD should directly address the lack of incentives that allow current underlying problems to persist.**

The DoD currently experiences a number of acquisition difficulties that stem largely from poor decisions. Despite ample warning and past experience, the DoD continues to fund projects with unreasonable cost and schedule estimates, unrealistic performance expectations, and "fixed" requirements (even when a program's performance is based on immature technologies). These are compounded by external influences, such as Congressional decisions to shift funding levels and restrictive oversight requirements. Many of the DoD's acquisition difficulties could be avoided or minimized if DoD officials would fully implement current policies and best practices.

At present, DoD officials have few incentives—and, in some cases, limited authority—to ensure that programs are initiated based on realistic cost and schedule estimates. In order to create the desired cultural changes, the Secretary/Deputy Secretary of

Defense/USD(AT&L), the Service Secretaries/Military Chiefs, and Defense Agency heads must create a new incentive system for leaders, managers, and employees that encourages and rewards employees for improving the efficiency of the DoD's acquisition system. Individual performance awards and promotions should be used to acknowledge significant achievements toward reaching acquisition program objectives.

**Congress and the DoD Should Work to Increase Funding Flexibility.**

DoD programs may face programmatic difficulties for a number of different reasons. Many small yet unexpected difficulties become significant problems over time as program managers do not have the budgetary flexibility required to implement a solution quickly. For example, DoD program managers should be able to use production money to increase development costs so as to save far more significant unit production costs, as is done in the commercial sector. Development teams need to be able to take advantage of opportunities as they arise or avoid technical difficulties as necessary. As requirements shift, programs need greater latitude to realign funds within the scope of the total-program. We believe the DoD would benefit greatly from enhanced funding flexibility—a staple in the commercial sector—in terms of better acquisition outcomes.

**Provide Programs with Greater Requirements Flexibility.**

Users must allow more flexibility with system requirements in order to allow program managers to direct programs more effectively. In many instances, users must be willing to accept less capable systems (the "80 percent solution") earlier, and then evolve to desired capability in later blocks. By accepting less technologically challenging solutions in the near term, users allow system developers greater ability to make necessary cost, performance, and schedule tradeoffs as they arise (although cost should typically be viewed as a design constraint). For example, a program manager should be allowed to make cost/performance tradeoffs, particularly for block I of a deployed system, to ensure that the last 5–10% of the performance "requirements" don't double the unit-costs. DoD programs generally do not demonstrate this adaptability until budget overruns require significant action.

## Conclusion

The DoD typically funds a small number of very large defense acquisition projects. Due to their size and importance, each program is deemed to be vitally important to national security. Despite a long history of significant developmental difficulties, defense acquisition projects have rarely been cancelled by either the DoD or Congress, both of which cite national security concerns. Moreover, only a small percentage of cancelled programs have been cancelled due solely to budgetary concerns. Consequently, programs face few consequences for missing budgetary estimates, undermining the effectiveness of NM.

In a book originally published in 1983, Norman Augustine made the following quip based on cost-growth trends: "in the year 2054, the entire defense budget will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3 ½ days each per week except for leap year, when it will be made available to the Marines for the extra day" (Augustine, 1997). Sadly, program and unit-cost-growth have not improved significantly since the publication of that book. The DoD has historically compensated for program cost-growth through increased budgets (most recently with the sharply increased budgets and supplementals supporting operations in Iraq and Afghanistan). Based on the current budgetary environment, however, we believe the DoD will soon enter an era of constrained budgets. The DoD's acquisition process—including its oversight procedures—requires reform in order to allow the DoD to provide the nation with the weapons it needs at an affordable cost.

# Appendix A: Programs that reported unit-cost-growth and/or Nunn–McCurdy breach, 1998-2008

| Programs listed in the December 2007 *SAR* Summary Table[14] | High Unit-cost-growth[15] | Nunn–McCurdy Breach[16] |
|---|---|---|
| | | |
| 1. AEHF (Advanced Extremely High Frequency) | 2[17] | 2[18] |
| 2. AGM-88E AARGM (Advanced Anti-Radiation Guided Missile) | 0[19] | 0 |
| 3. AIM-9X (Sidewinder) | 0 | 0 |
| 4. AMRAAM (Advanced Medium Range Air-to-Air Missile) | 2 | 0 |
| 5. ATIRCM/CMWS (Advanced Threat Infrared Countermeasure/Common Missile Warning System) | 1 | 1 |
| 6. B-2 RMP (Radar Modernization Program) | 0 | 0 |
| 7. BMDS (Ballistic Missile Defense System) | 0 | 0 |
| 8. Bradley Upgrade | 2 | 0 |
| 9. C-130 AMP (Avionics Modernization Program) | 2 | 2 |
| 10. C-130J | 0 | 0 |
| 11. C-17A | 2 | 0 |
| 12. C-5 RERP (Reliability Enhancement and Re-engining Program) | 2 | 2 |
| 13. CEC (Cooperative Engagement Capability) | 0 | 0 |
| 14. CHEM DEMIL-ACWA (Chemical Demilitarization-Assembled Chemical Weapons Alternatives) | 2 | 2 |
| 15. CHEM DEMIL-CMA (Chemical Demilitarization-Chemical Materials Agency) | 1 | 1 |
| 16. COBRA JUDY REPLACEMENT | 0 | 0 |
| 17. CVN 21 | 0 | 0 |
| 18. CVN 68 | 0 | 0 |

14 Programs are only listed once, regardless of the number of times a program experienced high unit-cost-growth or an NM breach. This table conveys the most recently reported infraction by a program.
15 A program is noted as having high unit-cost-growth if a SAR Summary Table specifically states either (a) a program has experienced unit-cost-growth in excess of 15% or (b) a program has experienced a Nunn–McCurdy breach.
16 A program is noted as having a Nunn–McCurdy breach if, and only if, a SAR Summary Table specifically states a program has experienced a Nunn–McCurdy breach.
17 The number 0 denotes no reported high unit-cost-growth. The number 1 denotes unit-cost-growth at or above the significant unit-cost level but below the critical unit-cost level, whereas 2 indicates unit-cost-growth at or above the "critical" unit-cost level. The number 3 denotes the statement that unit-cost-growth or an NM breach occurred but gives no indication of the level of the problem.
18 The number 0 denotes no reported NM breach; 1 indicates a significant unit-cost breach; 2 indicates a critical unit-cost breach; and 3 implies a statement that an NM breach occurred but does not give an indication of the severity of the infraction.
19 NB: A program is assumed not to have incurred high unit-cost or an NM breach if a SAR Summary Table did not explicitly state that such an event had occurred. This may be an erroneous assumption, especially for data before the 2006 revision of NM.

| | | |
|---|---|---|
| 19. DDG 51 | 0 | 0 |
| 20. E-2D AHE (Advanced Hawkeye) | 0 | 0 |
| 21. EA-18G | 0 | 0 |
| 22. F/A-18E/F | 1 | 1 |
| 23. F-35 (Joint Strike Fighter) | 1 | 1 |
| 24. FAB-T (Family of Advanced Beyond Line-of-Sight Terminals) | 0 | 0 |
| 25. FCS (Future Combat System) | 2 | 0 |
| 26. FMTV (Family of Medium Tactical Vehicles) | 2 | 0 |
| 27. GBS (Global Broadcast Service) | 0 | 0 |
| 28. Global Hawk (RQ-4A/B) | 2 | 2 |
| 29. GMLRS (Guided Multiple Launch Rocket System) | 2 | 2 |
| 30. H-1 UPGRADES (4BW/4BN) | 2 | 0 |
| 31. HIMARS (High Mobility Artillery Rocket System) | 0 | 0 |
| 32. JASSM (Joint Air-to-Surface Standoff Missile) | 2 | 2 |
| 33. JAVELIN | 1 | 1 |
| 34. JDAM (Joint Direct Attack Munition) | 0 | 0 |
| 35. JPATS (Joint Primary Aircraft Training System) | 2 | 2 |
| 36. JSOW (Joint Standoff Weapon)–BASELINE/BLU-108 | 2 | 0 |
| 37. JSOW (Joint Standoff Weapon)–UNITARY | 2 | 0 |
| 38. JTRS GMR (Joint Tactical Radio System Ground Mobile Radio) | 1 | 1 |
| 39. JTRS HMS (Joint Tactical Radio System Handheld, Manpack, Small Form Fit) | 0 | 0 |
| 40. JTRS NED (Joint Tactical Radio System Network Enterprise Domain) | 0 | 0 |
| 41. LCS (Littoral Combat Ship) | 0 | 0 |
| 42. LONGBOW APACHE | 2 | 0 |
| 43. LPD 17 | 2 | 0 |
| 44. MH-60S | 1 | 1 |
| 45. MIDS (Multifunctional Information Distribution System) | 0 | 0 |
| 46. MINUTEMAN III GRP (Guidance Replacement Program) | 2 | 0 |
| 47. MINUTEMAN III PRP (Propulsion Replacement Program) | 0 | 0 |
| 48. MP RTIP (Multi-Platform Radar Technology Insertion Program) | 0 | 0 |
| 49. MPS (Mission Planning System) | 0 | 0 |
| 50. MUOS (Mobile User Objective System) | 0 | 0 |
| 51. NAVSTAR GPS (Navigation Signal Timing and Ranging Global Positioning System)–SPACE & CONTROL | 0 | 0 |
| 52. NAVSTAR GPS (Navigation Signal Timing and Ranging Global Positioning System)–USER EQUIPMENT | 0 | 0 |
| 53. NMT (Navy Multiband Terminal) | 0 | 0 |

| | | |
|---|---|---|
| 54. NPOESS (National Polar-Orbiting Operational Environmental Satellite System) | 2 | 2 |
| 55. P-8A MAA (Multi-Mission Maritime Aircraft) | 0 | 0 |
| 56. PATRIOT PAC-3 (Patriot Advanced Capability-3) | 0 | 0 |
| 57. PATRIOT/MEADS (Medium Extended Air Defense System) CAP–FIRE UNIT | 0 | 0 |
| 58. PATRIOT/MEADS (Medium Extended Air Defense System) CAP–MISSILE | 0 | 0 |
| 59. SBIRS (Space Based Infrared Systems)–High | 1 | 1 |
| 60. SDB I (Small Diameter Bomb I) | 0 | 0 |
| 61. SM-6 (Extended Range Active Missile) | 0 | 0 |
| 62. SSDS (Ship Self-Defense System) | 0 | 0 |
| 63. SSGN (Guided Missile Submarines) | 0 | 0 |
| 64. SSN-774 (Virginia Class) | 1 | 1 |
| 65. STRYKER | 0 | 0 |
| 66. T-45TS | 2 | 0 |
| 67. TACTICAL TOMAHAWK | 0 | 0 |
| 68. T-AKE (Dry Cargo/Ammunition Ship) | 0 | 0 |
| 69. TRIDENT II MISSILE | 2 | 0 |
| 70. VH-71 (Presidential Helicopter) | 0 | 0 |
| 71. WGS (Wideband Gapfiller Satellites) | 0 | 0 |
| | | |
| Number of programs | 31 | 18 |
| | | |
| ARH (Armed Reconnaissance Helicopter) | 1 | 1 |
| ASDS (Advanced Deployable System) | 2 | 2 |
| Black Hawk Upgrade | 2 | 0 |
| CH-47F | 2 | 0 |
| EEVL (Evolved Expendable Launch Vehicle) | 2 | 0 |
| EFV (Expeditionary Fighting Vehicle) | 2 | 2 |
| F-22 | 1 | 1 |
| FBCB2 (Force XXI Battle Command Brigade and Below) | 1 | 1 |
| Land Warrior | 2 | 2 |
| MH-60R | 2 | 0 |
| Navy Area TBMD | 3 | 3 |
| V-22 | 2 | 0 |
| | | |
| Number of programs | 13 | 8 |
| | | |
| Overall number of program | 44 | 26 |

**Figure 10: Programs that reported unit-cost-growth and/or Nunn–McCurdy breach, 1998–2008**

## Appendix B: December 2007 *SAR* Summary Table

## Program Acquisition Cost Summary (Dollars in Millions)
## As Of December 31, 2007

| Program | Base Year | Baseline Type | Baseline Estimate | | | Changes To Date | | | Current Estimate | | | % Change To Date Adjusted for Qty | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ |
| **Army:** | | | | | | | | | | | | | |
| APACHE BLOCK III (AB3) | 2006 | DE | 6,553.0 | 8,093.9 | 602 | 605.4 | 902.5 | 37 | 7,158.4 | 8,996.4 | 639 | 4.9 | 6.0 |
| ARH | 2005 | DE | 3,149.1 | 3,568.7 | 368 | 2,110.6 | 2,768.0 | 144 | 5,259.7 | 6,336.7 | 512 | 36.3 | 41.8 |
| ATIRCM/CMWS | 2003 | PdE | 2,795.7 | 3,240.6 | 2,668 | 1,374.1 | 1,575.3 | 921 | 4,169.8 | 4,815.9 | 3,589 | 1.8 | -4.5 |
| BLACK HAWK UPGRADE (UH-60M) | 2005 | PdE | 16,801.7 | 20,847.1 | 1,235 | 2,133.5 | 3,195.6 | - | 18,935.2 | 24,042.7 | 1,235 | 12.7 | 15.3 |
| BRADLEY UPGRADE | 2001 | PdE | 3,724.2 | 3,859.8 | 926 | 4,845.6 | 5,835.4 | 1,642 | 8,569.8 | 9,695.2 | 2,568 | 5.2 | 2.5 |
| CH-47F | 2005 | PdE | 10,614.8 | 12,147.4 | 512 | 900.8 | 1,202.9 | 1 | 11,515.6 | 13,350.3 | 513 | 8.3 | 9.7 |
| EXCALIBUR | 2007 | PdE | 2,264.6 | 2,518.7 | 30,388 | -32.1 | -53.6 | - | 2,232.5 | 2,465.1 | 30,388 | -1.4 | -2.1 |
| FBCB2 | 2005 | PdE | 1,579.9 | 1,556.7 | 22,248 | 1,640.9 | 1,814.4 | 51,215 | 3,220.8 | 3,371.1 | 73,463 | 20.2 | 21.4 |
| FCS | 2003 | DE | 77,800.0 | 92,200.0 | 15 | 34,624.5 | 67,120.2 | - | 112,424.5 | 159,320.2 | 15 | 44.5 | 72.8 |
| FMTV | 1996 | PdE | 11,594.2 | 18,921.3 | 85,488 | 4,922.4 | 1,755.1 | -2,303 | 16,516.6 | 20,676.4 | 83,185 | 43.7 | 12.8 |
| GMLRS | 2003 | PdE | 9,780.2 | 11,848.9 | 140,239 | -5,062.5 | -5,840.6 | -96,444 | 4,717.7 | 6,008.3 | 43,795 | 22.5 | 105.3 |
| HIMARS | 2003 | PdE | 3,711.6 | 4,388.4 | 894 | -1,914.4 | -2,339.4 | -513 | 1,797.2 | 2,049.0 | 381 | -11.1 | -0.3 |
| JAVELIN | 1997 | PdE | 3,791.1 | 3,926.0 | 28,453 | 903.2 | 998.0 | -2,990 | 4,694.3 | 4,924.0 | 25,463 | 10.2 | 10.6 |
| JLENS | 2005 | DE | 5,850.0 | 7,151.0 | 16 | 238.6 | 349.3 | - | 6,088.6 | 7,500.3 | 16 | 4.1 | 4.9 |
| LONGBOW APACHE | 1996 | PdE | 5,690.6 | 7,027.8 | 758 | 4,135.4 | 4,155.2 | -87 | 9,826.0 | 11,183.0 | 671 | 67.4 | 55.3 |
| LUH | 2006 | PdE | 1,638.3 | 1,883.0 | 322 | 181.5 | 207.2 | 23 | 1,819.8 | 2,090.2 | 345 | 4.1 | 3.4 |
| PATRIOT PAC-3 | 2002 | PdE | 9,084.0 | 9,205.8 | 1,159 | -697.3 | -680.9 | -190 | 8,386.7 | 8,524.9 | 969 | -2.7 | -1.4 |
| PATRIOT/MEADS CAP - FIRE UNIT | 2004 | DE | 16,530.5 | 21,839.4 | 48 | -722.3 | -59.7 | - | 15,808.2 | 21,779.7 | 48 | -4.4 | -0.3 |
| PATRIOT/MEADS CAP - MISSLE | 2004 | DE | 6,220.9 | 8,056.0 | 1,528 | -193.6 | 59.5 | - | 6,027.3 | 8,115.5 | 1,528 | -3.1 | 0.7 |
| STRYKER | 2004 | PdE | 8,276.9 | 8,534.7 | 2,096 | 5,977.6 | 7,156.4 | 1,441 | 14,254.5 | 15,691.1 | 3,537 | 18.5 | 21.5 |
| WIN-T INCREMENT 1 | 2007 | PdE | 3,798.0 | 3,879.7 | 1,677 | - | -20.0 | - | 3,798.0 | 3,859.7 | 1,677 | 0.0 | -0.5 |
| WIN-T INCREMENT 2 | 2007 | DE | 3,445.8 | 3,907.0 | 1,893 | - | -36.2 | - | 3,445.8 | 3,870.8 | 1,893 | 0.0 | -0.9 |
| **Subtotal** | | | **214,695.1** | **258,601.9** | | **55,971.9** | **90,064.6** | | **270,667.0** | **348,666.5** | | **23.7** | **33.4** |
| **Navy:** | | | | | | | | | | | | | |
| ADS (AN/WQR-3) | 2005 | DE | 1,337.0 | 1,431.7 | 15 | -784.9 | -902.9 | -15 | 552.1 | 528.8 | - | -36.7 | -38.9 |
| AGM-88E AARGM | 2003 | DE | 1,339.8 | 1,510.9 | 1,790 | 86.0 | 199.2 | 121 | 1,425.8 | 1,710.1 | 1,911 | 3.2 | 9.1 |
| AIM-9X | 1997 | PdE | 2,464.0 | 3,232.9 | 10,049 | 200.1 | 162.6 | 93 | 2,664.1 | 3,395.5 | 10,142 | 7.6 | 4.4 |
| CEC | 2002 | PdE | 4,123.3 | 4,310.7 | 272 | 83.7 | 219.8 | 34 | 4,207.0 | 4,530.5 | 306 | 1.5 | 4.6 |
| CH-53K | 2006 | DE | 14,980.9 | 18,766.3 | 156 | 44.0 | -58.0 | - | 15,024.9 | 18,708.3 | 156 | 0.3 | -0.3 |
| COBRA JUDY REPLACEMENT | 2003 | DE | 1,365.0 | 1,464.0 | 1 | 88.3 | 165.5 | - | 1,453.3 | 1,629.5 | 1 | 6.5 | 11.3 |
| CVN 21 | 2000 | DE | 28,701.2 | 36,082.1 | 3 | -3,714.1 | -963.0 | - | 24,987.1 | 35,119.1 | 3 | -12.9 | -2.7 |
| CVN 68 | 1995 | PdE | 4,557.1 | 5,540.8 | 1 | 721.7 | 718.0 | - | 5,278.8 | 6,258.8 | 1 | 15.8 | 13.0 |
| DDG 1000 | 2005 | DE | 31,547.9 | 36,296.3 | 10 | -6,457.5 | -7,409.6 | -3 | 25,090.4 | 28,886.7 | 7 | -0.5 | 3.9 |
| DDG 51 | 1987 | PdE | 16,953.7 | 20,117.5 | 23 | 29,464.4 | 42,638.8 | 39 | 46,418.1 | 62,756.3 | 62 | 11.5 | 10.0 |
| E-2D AHE | 2002 | DE | 12,225.0 | 14,982.0 | 75 | 1,168.9 | 2,449.1 | - | 13,393.9 | 17,431.1 | 75 | 9.6 | 16.3 |
| EA-18G | 2004 | PdE | 7,530.8 | 8,636.4 | 84 | 47.5 | 12.7 | 1 | 7,578.3 | 8,649.1 | 85 | -0.2 | -0.7 |
| EFV | 2007 | DE | 8,493.2 | 8,725.2 | 1,025 | 4,671.1 | 7,135.0 | -432 | 13,164.3 | 15,860.2 | 593 | 114.8 | 174.6 |
| ERM | 2005 | DE | 1,242.7 | 1,478.0 | 15,100 | 44.8 | 43.4 | - | 1,287.5 | 1,521.4 | 15,100 | 3.6 | 2.9 |
| F/A-18E/F | 2000 | PdE | 38,884.7 | 41,637.3 | 458 | 4,372.9 | 4,707.5 | 35 | 43,257.6 | 46,344.8 | 493 | 7.1 | 6.5 |
| H-1 UPGRADES (4BW/4BN) | 1996 | DE | 2,792.5 | 3,547.5 | 284 | 3,957.8 | 5,180.0 | - | 6,750.3 | 8,727.5 | 284 | 141.7 | 146.0 |
| JSOW - BASELINE/BLU-108 | 1990 | PdE | 3,566.3 | 4,898.7 | 16,124 | -2,090.4 | -3,037.1 | -12,790 | 1,475.9 | 1,861.6 | 3,334 | -2.1 | 9.9 |
| JSOW - UNITARY | 1990 | PdE | 1,977.8 | 2,974.8 | 7,000 | -200.7 | -249.7 | - | 1,777.1 | 2,725.1 | 7,000 | -10.1 | -8.4 |
| LCS | 2004 | PE | 1,172.7 | 1,211.7 | 2 | 1,422.5 | 1,636.9 | - | 2,595.2 | 2,848.6 | 2 | 121.3 | 135.1 |
| LHA REPLACEMENT | 2006 | DE | 2,877.4 | 3,093.5 | 1 | 201.5 | 274.4 | - | 3,078.9 | 3,367.9 | 1 | 7.0 | 8.9 |
| LPD 17 | 1996 | DE | 9,018.1 | 10,761.8 | 12 | 2,489.9 | 3,479.9 | -3 | 11,508.0 | 14,241.7 | 9 | 92.0 | 111.8 |
| MH-60R | 2006 | PdE | 10,627.0 | 11,424.7 | 254 | 652.3 | 714.7 | - | 11,279.3 | 12,139.4 | 254 | 6.1 | 6.3 |
| MH-60S | 1998 | PdE | 5,270.1 | 6,093.8 | 237 | 1,234.1 | 1,749.2 | 34 | 6,504.2 | 7,843.0 | 271 | 12.4 | 15.6 |
| MUOS | 2004 | DE/PdE | 5,738.0 | 6,481.1 | 6 | -71.0 | 200.6 | - | 5,667.0 | 6,681.7 | 6 | -1.2 | 3.1 |
| NMT | 2002 | DE | 1,923.4 | 2,321.1 | 333 | -246.6 | -217.8 | -28 | 1,676.8 | 2,103.3 | 305 | -12.8 | -9.2 |
| P-8A (MMA) | 2004 | DE | 26,494.0 | 31,428.6 | 115 | -311.2 | 1,424.3 | -2 | 26,182.8 | 32,852.9 | 113 | -0.5 | 5.2 |
| RMS | 2006 | PdE | 1,304.6 | 1,399.4 | 108 | 74.9 | 150.3 | - | 1,379.5 | 1,549.7 | 108 | 6.0 | 9.9 |
| SM-6 | 2004 | DE | 4,866.3 | 5,983.3 | 1,200 | -173.8 | -28.9 | - | 4,692.5 | 5,954.4 | 1,200 | -3.6 | -0.5 |

## Program Acquisition Cost Summary (Dollars in Millions)
## As Of December 31, 2007

| Program | Base Year | Baseline Type | Baseline Estimate | | | Changes To Date | | | Current Estimate | | | % Change To Date Adjusted for Qty | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ | Quantity | Base Year $ | Then Year $ |
| SSDS | 2004 | PdE | 510.1 | 550.3 | 18 | 46.5 | 118.6 | 24 | 556.6 | 668.9 | 42 | -36.1 | -33.1 |
| SSGN | 2002 | PdE | 3,869.1 | 4,051.9 | 4 | -1.7 | 56.6 | - | 3,867.4 | 4,108.5 | 4 | 0.0 | 1.4 |
| SSN 774 (VIRGINIA CLASS) | 1995 | DE | 45,633.1 | 71,080.8 | 30 | 18,118.7 | 20,884.4 | - | 63,751.8 | 91,965.2 | 30 | 39.7 | 29.4 |
| T-45TS | 1995 | PdE | 5,528.1 | 5,599.5 | 176 | 1,207.3 | 1,228.7 | 47 | 6,735.4 | 6,828.2 | 223 | 5.7 | 4.7 |
| TACTICAL TOMAHAWK | 1999 | PdE | 2,977.3 | 3,290.3 | 2,790 | 728.3 | 1,085.0 | 502 | 3,705.6 | 4,375.3 | 3,292 | 15.3 | 20.8 |
| T-AKE | 2000 | PdE | 4,262.6 | 4,890.2 | 12 | 355.6 | 825.0 | - | 4,618.2 | 5,715.2 | 12 | 7.9 | 15.2 |
| TRIDENT II MISSILE | 1983 | PdE | 26,556.3 | 35,518.5 | 845 | -174.5 | 3,298.9 | -284 | 26,381.8 | 38,817.4 | 561 | 16.8 | 34.8 |
| V-22 | 2005 | PdE | 50,250.4 | 53,253.4 | 458 | 222.4 | 973.5 | - | 50,472.8 | 54,226.9 | 458 | 0.4 | 1.8 |
| VH-71 | 2003 | DE | 5,653.6 | 6,547.3 | 23 | 77.9 | 202.9 | 5 | 5,731.5 | 6,750.2 | 28 | -3.3 | -2.2 |
| VTUAV | 2006 | DE/PdE | 2,366.4 | 2,787.1 | 177 | -491.6 | -628.8 | - | 1,874.8 | 2,158.3 | 177 | -20.8 | -22.6 |
| **Subtotal** | | | **400,981.5** | **483,401.4** | | **57,065.1** | **88,439.7** | | **458,046.6** | **571,841.1** | | **11.4** | **14.6** |
| **Air Force:** | | | | | | | | | | | | | |
| AEHF | 2002 | DE/PdE | 5,279.2 | 5,645.3 | 5 | 1,459.1 | 1,716.7 | -1 | 6,738.3 | 7,362.0 | 4 | 29.2 | 30.9 |
| AMRAAM | 1992 | PdE | 12,278.2 | 13,112.4 | 15,450 | 878.1 | 1,768.2 | -1,497 | 13,156.3 | 14,880.6 | 13,953 | 17.3 | 30.9 |
| B-2 EHF INCREMENT 1 | 2007 | DE | 659.7 | 706.1 | 21 | -23.3 | -25.1 | - | 636.4 | 681.0 | 21 | -3.5 | -3.6 |
| B-2 RMP | 2004 | DE | 1,148.4 | 1,220.0 | 21 | -54.7 | 5.4 | - | 1,093.7 | 1,225.4 | 21 | -4.8 | 0.4 |
| C-130 AMP | 2000 | DE | 3,333.9 | 3,965.4 | 519 | 1,187.1 | 1,834.8 | -297 | 4,521.0 | 5,800.2 | 222 | 76.9 | 102.8 |
| C-130J | 1996 | PdE | 730.7 | 839.7 | 11 | 9,074.0 | 11,189.6 | 123 | 9,804.7 | 12,029.3 | 134 | 31.4 | 30.3 |
| C-17A | 1996 | PdE | 41,250.9 | 41,811.9 | 210 | 17,413.9 | 20,494.8 | -20 | 58,664.8 | 62,306.7 | 190 | 45.1 | 55.1 |
| C-5 AMP | 2006 | PdE | 888.4 | 856.3 | 61 | 488.6 | 549.0 | 51 | 1,377.0 | 1,405.3 | 112 | 20.1 | 22.4 |
| C-5 RERP | 2000 | DE | 8,798.0 | 11,093.9 | 126 | -320.0 | 37.0 | -15 | 8,478.0 | 11,130.9 | 111 | 2.4 | 6.8 |
| F-22 | 2005 | PdE | 64,281.7 | 61,323.7 | 181 | 2,710.1 | 3,216.2 | 3 | 66,991.8 | 64,539.9 | 184 | 3.7 | 4.6 |
| FAB-T | 2002 | DE | 2,642.3 | 3,167.4 | 216 | 320.4 | 454.8 | 6 | 2,962.7 | 3,622.2 | 222 | 10.7 | 12.8 |
| GBS | 1997 | DE | 451.4 | 497.1 | 346 | 275.6 | 308.4 | 775 | 727.0 | 805.5 | 1,121 | 6.5 | 5.6 |
| GLOBAL HAWK (RQ-4A/B) | 2000 | DE | 4,350.3 | 5,394.0 | 63 | 3,751.6 | 4,346.7 | -9 | 8,101.9 | 9,740.7 | 54 | 101.1 | 98.5 |
| JASSM | 1995 | PdE | 4,016.4 | 4,981.1 | 5,447 | 449.7 | 1,084.7 | -441 | 4,466.1 | 6,065.8 | 5,006 | 18.0 | 30.2 |
| JDAM | 1995 | PdE | 2,300.3 | 2,606.7 | 89,065 | 2,221.8 | 2,653.4 | 112,928 | 4,522.1 | 5,260.1 | 201,993 | 28.3 | 29.6 |
| JPATS | 2002 | PdE | 4,529.0 | 5,041.1 | 783 | 385.5 | 493.2 | -15 | 4,914.5 | 5,534.3 | 768 | 9.9 | 11.5 |
| MINUTEMAN III GRP | 1993 | PdE | 2,012.5 | 2,400.1 | 652 | 82.9 | 27.6 | - | 2,095.4 | 2,427.7 | 652 | 5.9 | 2.8 |
| MINUTEMAN III PRP | 1994 | PdE | 2,086.8 | 2,600.8 | 607 | 103.0 | 1.0 | -6 | 2,189.8 | 2,601.8 | 601 | 5.5 | 0.5 |
| MP RTIP | 2000 | DE | 1,449.3 | 1,568.4 | - | -334.6 | -343.4 | - | 1,114.7 | 1,225.0 | - | -23.1 | -21.9 |
| MPS | 2004 | DE | 1,545.8 | 1,690.7 | 1 | -152.2 | -108.2 | - | 1,393.6 | 1,582.5 | 1 | -9.8 | -6.4 |
| NAS | 2005 | PdE | 1,373.2 | 1,421.1 | 93 | 50.3 | 69.6 | -2 | 1,423.5 | 1,490.7 | 91 | 4.8 | 6.3 |
| NAVSTAR GPS - SPACE & CONTROL | 2000 | PdE | 5,015.6 | 5,120.9 | 33 | 947.5 | 1,185.2 | - | 5,963.1 | 6,306.1 | 33 | 18.4 | 23.2 |
| NAVSTAR GPS - USER EQUIPMENT | 2000 | PdE | 797.8 | 874.4 | - | 992.8 | 1,219.3 | - | 1,790.6 | 2,093.7 | - | 124.4 | 139.4 |
| NPOESS | 2002 | PdE | 5,538.0 | 6,117.6 | 6 | 3,825.0 | 5,022.6 | -2 | 9,363.0 | 11,140.2 | 4 | 83.4 | 101.7 |
| SBIRS HIGH | 1995 | DE | 3,679.5 | 4,147.3 | 5 | 5,879.2 | 7,407.2 | -1 | 9,558.7 | 11,554.5 | 4 | 178.2 | 200.2 |
| SDB I | 2001 | PdE | 1,526.0 | 1,786.3 | 24,070 | -274.0 | -309.4 | - | 1,252.0 | 1,476.9 | 24,070 | -18.0 | -17.3 |
| WGS | 2001 | PdE | 980.4 | 1,042.5 | 3 | 784.0 | 908.0 | 2 | 1,764.4 | 1,950.5 | 5 | 14.5 | 16.3 |
| **Subtotal** | | | **182,943.7** | **191,032.2** | | **52,121.4** | **65,207.3** | | **235,065.1** | **256,239.5** | | **25.2** | **31.1** |
| **DoD:** | | | | | | | | | | | | | |
| BMDS | 2002 | PE | 44,740.1 | 47,217.1 | - | 44,658.2 | 55,695.3 | - | 89,398.3 | 102,912.4 | - | 99.8 | 118.0 |
| CHEM DEMIL-ACWA | 1994 | PdE | 1,957.4 | 2,430.4 | 3,134 | 3,541.4 | 5,561.5 | 2 | 5,498.8 | 7,991.9 | 3,136 | 180.9 | 228.8 |
| CHEM DEMIL-CMA | 1994 | PdE | 11,513.7 | 12,879.9 | 29,060 | 10,945.6 | 14,542.7 | - | 22,459.3 | 27,422.6 | 29,060 | 95.1 | 112.9 |
| DIMHRS | 2007 | DE | 947.5 | 922.3 | - | -97.3 | -103.4 | 1 | 850.2 | 818.9 | 1 | -10.3 | -11.2 |
| F-35 (JSF) | 2002 | DE | 177,100.0 | 233,000.0 | 2,866 | 32,914.5 | 65,842.8 | -410 | 210,014.5 | 298,842.8 | 2,456 | 30.6 | 44.0 |
| JTRS GMR | 2002 | DE | 14,437.2 | 19,112.9 | 108,388 | -194.1 | 1,423.5 | -21,736 | 14,243.1 | 20,536.4 | 86,652 | 13.3 | 27.6 |
| JTRS HMS | 2004 | DE | 8,569.0 | 10,717.0 | 328,674 | -5,897.2 | -7,350.1 | -232,713 | 2,671.8 | 3,366.9 | 95,961 | -42.7 | -36.1 |
| JTRS NED | 2002 | DE | 812.9 | 914.4 | - | 930.3 | 1,047.4 | - | 1,743.2 | 1,961.8 | - | 114.4 | 114.5 |
| MIDS | 2003 | PdE | 1,824.8 | 1,818.9 | 2,964 | 464.3 | 553.8 | 843 | 2,289.1 | 2,372.7 | 3,807 | 11.7 | 14.0 |
| **Subtotal** | | | **261,902.6** | **329,012.9** | | **87,265.7** | **137,213.5** | | **349,168.3** | **466,226.4** | | **45.4** | **57.8** |
| **Grand Total** | | | **1,060,522.9** | **1,262,048.4** | | **252,424.1** | **380,925.1** | | **1,312,947.0** | **1,642,973.5** | | **24.1** | **31.3** |

## Distribution of Cost Changes (Then Year Dollars in Millions)
## As Of December 31, 2007

| Program | Cost Changes Between the Baseline and Current Estimates | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Economic | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| **Army:** | | | | | | | | | | | | | | | | |
| APACHE BLOCK III (AB3) | -57.0 | -75.0 | - | 395.5 | 15.4 | 145.6 | - | - | 56.1 | 394.2 | - | - | -8.5 | 42.2 | 6.0 | 902.5 |
| ARH | -39.3 | 26.8 | - | 901.6 | 104.4 | 306.2 | -194.8 | 81.1 | 31.5 | 827.5 | - | - | 35.6 | 624.8 | -62.6 | 2,768.0 |
| ATIRCM/CMWS | -24.8 | 209.4 | - | 1,800.8 | -52.2 | -642.0 | 181.6 | -483.2 | -773.8 | 632.8 | - | - | -181.8 | 57.5 | -851.0 | 1,575.3 |
| BLACK HAWK UPGRADE (UH-60M) | -143.4 | 85.0 | - | - | -416.7 | 585.6 | - | 1,112.1 | 858.9 | 1,258.7 | - | - | -86.1 | 154.2 | 212.7 | 3,195.6 |
| BRADLEY UPGRADE | -33.7 | 4.2 | 831.4 | 5,597.3 | -5.1 | -293.6 | -102.6 | 751.1 | -112.5 | -884.3 | - | - | -167.9 | 660.7 | 409.6 | 5,835.4 |
| CH-47F | -65.8 | 103.9 | 23.4 | 23.4 | -49.7 | -152.0 | 0.5 | 0.5 | -21.3 | 1,279.4 | - | - | 14.4 | -52.3 | -98.5 | 1,202.9 |
| EXCALIBUR | -22.5 | -27.3 | - | - | 0.1 | 0.1 | - | - | 23.1 | -27.0 | - | - | - | 0.6 | 0.7 | -53.6 |
| FBCB2 | -5.3 | 29.4 | 683.0 | 1,220.8 | -28.9 | -41.4 | 18.1 | 114.9 | -95.6 | 124.9 | - | - | 113.7 | 365.8 | 685.0 | 1,814.4 |
| FCS | -1,331.0 | 5,552.6 | - | - | - | 20,101.7 | - | 23,940.6 | -1,047.5 | 7,017.0 | - | - | -231.4 | 10,508.3 | -2,609.9 | 67,120.2 |
| FMTV | -97.7 | -2,525.5 | - | -597.8 | -669.2 | -1,729.9 | -0.3 | 3,030.3 | 1,409.4 | 3,451.2 | - | - | -767.8 | 126.8 | -125.6 | 1,755.1 |
| GMLRS | -59.2 | 669.4 | - | -8,922.7 | -68.9 | 1,291.4 | - | - | -633.4 | 1,110.3 | - | - | -2.7 | 11.0 | -764.2 | -5,840.6 |
| HIMARS | -10.9 | 247.3 | - | -2,332.3 | - | -17.3 | - | 39.6 | -32.0 | -136.3 | - | - | 3.2 | -140.4 | -39.7 | -2,339.4 |
| JAVELIN | -3.7 | -55.0 | 341.1 | 524.7 | -2.1 | -22.8 | - | 7.0 | 22.4 | 519.5 | - | - | 67.0 | 24.6 | 424.7 | 998.0 |
| JLENS | -51.2 | 81.8 | - | - | -42.1 | -43.0 | - | - | -78.4 | 237.5 | - | - | 304.7 | 73.0 | 133.0 | 349.3 |
| LONGBOW APACHE | -14.8 | -251.1 | 110.6 | 172.3 | - | 22.3 | - | 2,530.1 | 69.8 | 1,197.5 | - | - | -17.4 | 484.1 | 148.2 | 4,155.2 |
| LUH | -10.8 | -5.3 | 139.3 | 139.3 | 6.4 | -2.1 | 84.9 | 84.9 | -1.4 | -8.0 | - | - | -10.0 | -1.6 | 208.4 | 207.2 |
| PATRIOT PAC-3 | -10.9 | 170.8 | - | -558.9 | - | 43.4 | - | - | 14.1 | -336.2 | - | - | - | - | 3.2 | -680.9 |
| PATRIOT/MEADS CAP - FIRE UNIT | -212.6 | 875.6 | - | - | - | - | - | - | -10.4 | -813.2 | - | - | -2.9 | -122.1 | -225.9 | -59.7 |
| PATRIOT/MEADS CAP - MISSLE | -82.2 | 314.8 | - | - | - | 13.0 | - | - | 30.5 | -268.4 | - | - | -4.8 | 0.1 | -56.5 | 59.5 |
| STRYKER | -82.9 | 171.6 | 1,907.2 | 4,381.7 | -94.5 | -176.4 | 1,099.8 | 1,862.6 | -62.4 | -253.1 | - | - | -207.0 | 1,170.0 | 2,560.2 | 7,156.4 |
| WIN-T INCREMENT 1 | -19.8 | -19.8 | - | - | -0.6 | -0.6 | - | - | -3.0 | -3.0 | - | - | 3.4 | 3.4 | -20.0 | -20.0 |
| WIN-T INCREMENT 2 | -35.8 | -35.8 | - | - | - | - | - | - | 86.0 | 86.0 | - | - | -86.4 | -86.4 | -36.2 | -36.2 |
| **Subtotal** | -2,415.3 | 5,547.8 | 4,036.0 | 2,745.7 | -1,303.7 | 19,388.2 | 1,087.2 | 33,071.6 | -269.9 | 15,407.0 | - | - | -1,232.7 | 13,904.3 | -98.4 | 90,064.6 |
| **Navy:** | | | | | | | | | | | | | | | | |
| ADS (AN/WQR-3) | 22.8 | -2.1 | - | -566.5 | - | 7.7 | - | - | -22.8 | -186.5 | - | - | - | -155.5 | - | -902.9 |
| AGM-88E AARGM | -9.6 | 69.4 | -3.5 | 55.9 | 27.8 | 26.0 | - | 0.8 | 48.4 | 80.5 | - | - | -44.3 | -33.4 | 18.8 | 199.2 |
| AIM-9X | -19.7 | -209.5 | - | 19.5 | 21.4 | 216.8 | - | 249.9 | 1.3 | 202.0 | - | - | 4.5 | -316.1 | 7.5 | 162.6 |
| CEC | -0.3 | 70.0 | 185.9 | 20.3 | 10.1 | 109.6 | -33.4 | 213.0 | -283.5 | -255.8 | - | - | 203.0 | 62.7 | 81.8 | 219.8 |
| CH-53K | -132.3 | -59.2 | - | - | - | - | - | - | -52.5 | -25.5 | - | - | 2.7 | 26.7 | -182.1 | -58.0 |
| COBRA JUDY REPLACEMENT | -2.4 | 56.7 | - | - | - | - | - | - | 111.4 | 108.8 | - | - | - | - | 109.0 | 165.5 |
| CVN 21 | 325.3 | 3,881.4 | - | - | - | 265.8 | - | -963.6 | -234.9 | -4,146.6 | - | - | - | - | 90.4 | -963.0 |
| CVN 68 | 25.3 | -176.4 | - | - | - | -54.5 | - | -65.7 | -6.7 | 887.6 | - | 127.0 | - | - | 18.6 | 718.0 |
| DDG 1000 | 291.0 | 1,022.0 | -8,495.0 | -8,495.0 | -64.2 | 85.8 | 591.1 | -249.7 | 541.7 | 227.3 | - | - | - | - | -7,135.4 | -7,409.6 |
| DDG 51 | 53.5 | -3,833.3 | - | 36,929.9 | - | 985.1 | - | 2,250.7 | -50.1 | 6,306.4 | - | - | - | - | 3.4 | 42,638.8 |
| E-2D AHE | -107.6 | 785.6 | - | - | - | 652.5 | - | 480.3 | 39.9 | 420.5 | - | - | 11.8 | 110.2 | -55.9 | 2,449.1 |
| EA-18G | -31.3 | -31.2 | - | 72.4 | - | -9.7 | - | - | 30.8 | 4.9 | - | - | -39.9 | -23.7 | -40.4 | 12.7 |
| EFV | -88.9 | 248.9 | - | -2,950.4 | - | 1,700.4 | - | 414.6 | -22.5 | 7,159.8 | - | - | -0.5 | 561.7 | -111.9 | 7,135.0 |
| ERM | -10.1 | -10.1 | - | - | - | - | - | - | 53.5 | 53.5 | - | - | - | - | 43.4 | 43.4 |
| F/A-18E/F | 142.9 | -246.3 | -64.8 | 1,864.0 | -12.6 | 1,061.9 | - | 223.1 | -46.2 | 5.1 | - | - | -63.3 | 1,799.7 | -44.0 | 4,707.5 |
| H-1 UPGRADES (4BW/4BN) | -56.0 | -138.6 | - | - | -5.0 | 542.6 | 75.2 | 638.3 | 100.2 | 3,110.7 | - | - | -93.4 | 1,027.0 | 21.0 | 5,180.0 |
| JSOW - BASELINE/BLU-108 | -2.1 | -30.5 | - | -3,204.5 | -0.6 | 379.8 | - | 104.0 | -12.1 | -265.7 | - | - | -2.6 | -20.2 | -17.4 | -3,037.1 |
| JSOW - UNITARY | -16.9 | 133.5 | - | - | 2.1 | 0.4 | 23.7 | 78.6 | -9.8 | -449.5 | - | - | -6.9 | -12.7 | -7.8 | -249.7 |
| LCS | -0.3 | 39.9 | - | - | 71.3 | 147.4 | 43.7 | 116.7 | 795.0 | 1,332.9 | - | - | - | - | 909.7 | 1,636.9 |
| LHA REPLACEMENT | 39.9 | 55.8 | - | - | - | - | - | - | -224.9 | -53.4 | 272.0 | 272.0 | - | - | 87.0 | 274.4 |
| LPD 17 | 98.9 | 460.6 | - | -4,037.8 | 6.1 | 774.2 | - | - | 49.6 | 4,696.4 | 493.1 | 1,586.5 | - | - | 647.7 | 3,479.9 |
| MH-60R | -52.9 | -20.6 | - | - | 14.4 | 68.5 | 15.6 | 207.3 | 789.8 | 803.1 | - | - | -329.2 | -343.6 | 437.7 | 714.7 |
| MH-60S | -28.5 | 215.4 | 83.5 | 690.3 | 1.3 | 242.6 | -0.3 | -46.0 | -176.0 | 303.5 | - | - | 53.4 | 343.4 | -66.6 | 1,749.2 |
| MUOS | -31.2 | 264.2 | - | - | - | - | - | - | 340.0 | -63.6 | - | - | - | - | 308.8 | 200.6 |
| NMT | 22.6 | 75.0 | -4.5 | -4.5 | 5.3 | 5.3 | - | - | -51.9 | -212.5 | - | - | -2.0 | -81.1 | -30.5 | -217.8 |
| P-8A (MMA) | -214.1 | 1,282.3 | -201.0 | -201.0 | 13.0 | 831.5 | 165.4 | 165.4 | 404.5 | -672.6 | - | - | 12.5 | 18.7 | 180.3 | 1,424.3 |
| RMS | -2.9 | -2.9 | - | 11.3 | 148.6 | 148.6 | - | - | 4.6 | 5.6 | - | - | -12.3 | -12.3 | 138.0 | 150.3 |
| SM-6 | -46.5 | 258.4 | - | - | -0.9 | -75.7 | - | - | 47.5 | -76.6 | - | - | -3.4 | -135.0 | -3.3 | -28.9 |
| SSDS | -1.5 | 10.5 | - | 450.2 | - | 17.3 | - | - | -4.0 | -351.2 | - | - | - | -8.2 | -5.5 | 118.6 |
| SSGN | 2.0 | 52.3 | - | - | - | - | - | 7.0 | 11.5 | -2.1 | - | - | -0.2 | -0.6 | 13.3 | 56.6 |
| SSN 774 (VIRGINIA CLASS) | 806.5 | -5,063.8 | - | - | -833.9 | 7,689.6 | - | 1,272.3 | -887.7 | 15,951.0 | - | 280.0 | -127.9 | 755.3 | -1,043.0 | 20,884.4 |

## Distribution of Cost Changes (Then Year Dollars in Millions)
## As Of December 31, 2007

| Program | Cost Changes Between the Baseline and Current Estimates | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Economic | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| T-45TS | -0.7 | 42.5 | -25.6 | 920.6 | 9.5 | -158.3 | -13.1 | 77.5 | 33.8 | 322.9 | - | - | -1.3 | 23.5 | 2.6 | 1,228.7 |
| TACTICAL TOMAHAWK | -18.1 | 88.1 | -228.0 | 330.2 | -7.6 | 233.0 | -2.2 | 24.7 | 91.8 | 353.0 | - | - | - | 56.0 | -164.1 | 1,085.0 |
| T-AKE | 38.7 | 265.2 | 471.0 | 72.2 | 9.3 | 33.5 | - | - | 567.4 | 454.1 | - | - | - | - | 1,086.4 | 825.0 |
| TRIDENT II MISSILE | -84.0 | -236.4 | - | -6,719.1 | - | 1,816.5 | -374.1 | 92.3 | -320.9 | 5,710.4 | - | - | 694.5 | 2,635.2 | -84.5 | 3,298.9 |
| V-22 | -231.4 | 66.3 | - | - | -11.2 | 746.0 | - | 213.2 | -29.5 | 36.2 | - | - | -137.8 | -88.2 | -409.9 | 973.5 |
| VH-71 | -21.9 | 33.8 | -98.2 | 352.4 | 203.0 | 203.0 | - | - | 492.1 | -381.9 | - | - | 30.4 | -4.4 | 605.4 | 202.9 |
| VTUAV | 40.9 | 40.9 | - | - | 2.5 | 2.5 | 40.2 | 40.2 | -15.2 | -701.7 | - | - | -10.7 | -10.7 | 57.7 | -628.8 |
| **Subtotal** | 699.1 | -542.2 | -8,380.2 | 15,610.4 | -390.3 | 18,695.7 | 531.8 | 5,544.9 | 2,103.6 | 40,691.0 | 765.1 | 2,265.5 | 137.1 | 6,174.4 | -4,533.8 | 88,439.7 |
| **Air Force:** | | | | | | | | | | | | | | | | |
| AEHF | -10.7 | 14.5 | 946.0 | -23.3 | - | 1,092.5 | -7.2 | 43.1 | 5.2 | 583.9 | - | - | 7.2 | 6.0 | 940.5 | 1,716.7 |
| AMRAAM | -26.8 | -311.2 | -156.7 | -1,746.1 | -50.1 | 1,829.4 | -6.5 | 1,126.1 | 254.4 | 681.6 | - | - | 74.4 | 188.4 | 88.7 | 1,768.2 |
| B-2 EHF INCREMENT 1 | -2.0 | -2.0 | - | - | 0.7 | 0.7 | - | - | -19.1 | -19.1 | - | - | -4.7 | -4.7 | -25.1 | -25.1 |
| B-2 RMP | 0.5 | 48.1 | - | - | 116.5 | 116.9 | - | - | -11.0 | -140.9 | - | - | -10.1 | -18.7 | 95.9 | 5.4 |
| C-130 AMP | -15.9 | -190.9 | -232.6 | -1,105.6 | -19.4 | 240.3 | - | 77.6 | 469.7 | 2,397.7 | - | - | -382.6 | 415.7 | -180.8 | 1,834.8 |
| C-130J | -1.8 | 122.8 | 2,937.8 | 8,390.1 | 224.6 | -398.6 | - | 169.1 | 165.5 | 129.9 | - | - | 632.1 | 2,776.3 | 3,958.2 | 11,189.6 |
| C-17A | -0.7 | -819.3 | - | -1,631.8 | - | 4,828.1 | - | 382.5 | -48.6 | 13,897.1 | - | 412.0 | -106.6 | 3,426.2 | -155.9 | 20,494.8 |
| C-5 AMP | -0.7 | -3.3 | - | 291.4 | - | 2.9 | - | 14.4 | -25.4 | -7.6 | - | - | 20.9 | 251.2 | -5.2 | 549.0 |
| C-5 RERP | -41.0 | 33.0 | - | -672.1 | - | 564.9 | - | -54.9 | -5,502.5 | -347.0 | - | - | -831.8 | 513.1 | -6,375.3 | 37.0 |
| F-22 | -15.9 | 67.7 | - | 374.9 | - | 65.0 | - | - | -721.6 | 1,838.4 | - | - | -15.3 | 870.2 | -752.8 | 3,216.2 |
| FAB-T | 26.6 | 26.6 | 44.7 | 44.7 | 9.2 | 9.2 | - | - | 316.0 | 316.0 | - | - | 58.3 | 58.3 | 454.8 | 454.8 |
| GBS | -0.5 | -10.2 | 10.1 | 266.0 | 10.3 | 43.3 | 10.2 | 101.9 | -80.0 | -101.9 | - | - | 0.1 | 9.3 | -49.8 | 308.4 |
| GLOBAL HAWK (RQ-4A/B) | -15.3 | 38.0 | - | -486.9 | - | -772.9 | 82.8 | 3,584.2 | -151.7 | 1,263.9 | - | - | 26.9 | 720.4 | -57.3 | 4,346.7 |
| JASSM | -23.5 | 178.5 | - | -323.2 | 13.5 | 213.0 | -129.2 | 14.7 | 384.0 | 993.5 | - | - | 24.7 | 8.2 | 269.5 | 1,084.7 |
| JDAM | -3.6 | 68.7 | -62.8 | 1,452.1 | 0.9 | -38.6 | - | 15.5 | 36.0 | 932.9 | - | - | -11.9 | 222.8 | -41.4 | 2,653.4 |
| JPATS | -13.8 | 36.5 | - | -76.0 | -0.1 | 57.8 | 226.8 | 441.0 | -247.6 | 110.1 | - | - | 32.5 | -76.2 | -2.2 | 493.2 |
| MINUTEMAN III GRP | 13.8 | 25.1 | - | -37.6 | - | 0.1 | - | - | -20.2 | 40.5 | - | - | -1.5 | -0.5 | -7.9 | 27.6 |
| MINUTEMAN III PRP | 17.8 | 13.9 | - | -11.5 | - | -29.8 | - | 25.5 | -30.7 | -35.2 | - | - | -5.0 | 38.1 | -17.9 | 1.0 |
| MP RTIP | -0.2 | 43.4 | - | - | - | 156.1 | - | -351.0 | -12.8 | -191.9 | - | - | - | - | -13.0 | -343.4 |
| MPS | -4.3 | 62.2 | - | - | - | -18.0 | - | 6.7 | 4.3 | -156.4 | - | - | - | -2.7 | - | -108.2 |
| NAS | -4.5 | 8.8 | - | -18.5 | -3.6 | 11.0 | - | - | 38.9 | 51.2 | - | - | -3.6 | 17.1 | 27.2 | 69.6 |
| NAVSTAR GPS - SPACE & CONTROL | -5.5 | 40.8 | - | -2.3 | - | 8.3 | - | 435.4 | -35.7 | 463.6 | - | - | -2.3 | 239.4 | -43.5 | 1,185.2 |
| NAVSTAR GPS - USER EQUIPMENT | -2.7 | 17.7 | - | - | - | - | - | 277.8 | 722.0 | 918.9 | - | - | -0.9 | 4.9 | 718.4 | 1,219.3 |
| NPOESS | -44.9 | 184.8 | - | -594.5 | - | 980.2 | 3.0 | -859.7 | 21.5 | 5,311.8 | - | - | - | - | -20.4 | 5,022.6 |
| SBIRS HIGH | -15.6 | 41.0 | 821.6 | -298.8 | - | 560.3 | 2.0 | 506.4 | 861.9 | 6,475.5 | - | - | 5.1 | 122.8 | 1,675.0 | 7,407.2 |
| SDB I | -5.0 | 35.1 | - | - | -1.6 | -11.7 | - | - | -1.3 | -332.3 | - | - | 1.1 | -0.5 | -6.8 | -309.4 |
| WGS | -1.2 | 27.3 | - | 634.2 | - | - | - | 63.2 | 7.9 | 203.5 | - | - | - | -20.2 | 6.7 | 908.0 |
| **Subtotal** | -197.4 | -202.4 | 4,308.1 | 4,425.2 | 300.9 | 9,510.4 | 181.9 | 6,019.5 | -3,620.9 | 35,277.7 | - | 412.0 | -493.0 | 9,764.9 | 479.6 | 65,207.3 |
| **DoD:** | | | | | | | | | | | | | | | | |
| BMDS | 4.7 | 2,325.1 | - | - | - | -1,684.3 | - | 56,455.0 | -380.4 | -1,400.5 | - | - | - | - | -375.7 | 55,695.3 |
| CHEM DEMIL-ACWA | -66.0 | 74.5 | - | - | - | -150.2 | - | - | 107.6 | 5,637.2 | - | - | - | - | 41.6 | 5,561.5 |
| CHEM DEMIL-CMA | -127.9 | 202.6 | - | - | - | 10,705.0 | - | - | -1,092.6 | 3,626.4 | - | 8.7 | - | - | -1,220.5 | 14,542.7 |
| DIMHRS | -1.9 | -1.9 | - | - | - | - | - | - | 15.5 | 15.5 | - | - | 0.2 | -117.0 | 13.8 | -103.4 |
| F-35 (JSF) | -1,955.8 | 5,309.9 | - | -25,434.9 | - | 29,614.1 | - | 12,789.3 | 17,841.8 | 41,528.3 | - | - | -16,867.3 | 2,036.1 | -981.3 | 65,842.8 |
| JTRS GMR | -140.7 | 879.4 | -2,420.2 | -3,020.0 | -480.1 | 1,488.4 | - | 12.4 | 2,979.4 | 1,817.8 | - | - | 269.9 | 245.5 | 208.3 | 1,423.5 |
| JTRS HMS | -66.5 | 648.8 | -5,444.4 | -5,444.4 | 157.6 | 334.5 | - | - | -2,195.9 | -2,016.5 | - | - | -872.5 | -872.5 | -8,421.7 | -7,350.1 |
| JTRS NED | -39.1 | -42.1 | - | - | - | - | - | 725.3 | -103.2 | 364.2 | - | - | - | - | -142.3 | 1,047.4 |
| MIDS | 6.3 | 27.4 | 135.7 | 261.8 | -2.3 | -6.0 | 55.7 | 296.7 | -0.1 | -3.0 | - | - | -20.8 | -23.1 | 174.5 | 553.8 |
| **Subtotal** | -2,386.9 | 9,423.7 | -7,728.9 | -33,637.5 | -324.8 | 40,301.5 | 55.7 | 70,278.7 | 17,172.1 | 49,569.4 | - | 8.7 | -17,490.5 | 1,269.0 | -10,703.3 | 137,213.5 |
| **Grand Total** | -4,300.5 | 14,226.9 | -7,765.0 | -10,856.2 | -1,717.9 | 87,895.8 | 1,856.6 | 114,914.7 | 15,384.9 | 140,945.1 | 765.1 | 2,686.2 | -19,079.1 | 31,112.6 | -14,855.9 | 380,925.1 |

## Distribution of Cost Changes (Base Year Dollars in Millions)
## As Of December 31, 2007

| Program | Base Year | Cost Changes Between the Baseline and Current Estimates | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| | | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| **Army:** | | | | | | | | | | | | | | | |
| APACHE BLOCK III (AB3) | 2006 | - | 269.2 | - | - | - | - | 43.9 | 307.4 | - | - | -3.3 | 28.8 | 40.6 | 605.4 |
| ARH | 2005 | - | 709.8 | 74.8 | 161.8 | -155.7 | 71.5 | 26.3 | 696.9 | - | - | 20.8 | 470.6 | -33.8 | 2,110.6 |
| ATIRCM/CMWS | 2003 | - | 1,299.3 | - | -153.9 | 159.6 | -301.6 | -544.0 | 465.9 | - | - | -128.3 | 64.4 | -512.7 | 1,374.1 |
| BLACK HAWK UPGRADE (UH-60M) | 2005 | - | - | - | 112.1 | - | 893.8 | 662.1 | 1,011.5 | - | - | -56.0 | 116.1 | 606.1 | 2,133.5 |
| BRADLEY UPGRADE | 2001 | 622.5 | 4,418.9 | 62.4 | 62.4 | -76.8 | 625.5 | -99.3 | -741.1 | - | - | -147.7 | 479.9 | 361.1 | 4,845.6 |
| CH-47F | 2005 | 17.3 | 17.3 | -0.1 | -0.1 | 0.5 | 0.5 | -37.8 | 920.5 | - | - | 9.8 | -37.4 | -10.3 | 900.8 |
| EXCALIBUR | 2007 | - | - | - | - | - | - | 20.1 | -32.6 | - | - | - | 0.5 | 20.1 | -32.1 |
| FBCB2 | 2005 | 606.4 | 1,099.3 | -4.1 | 3.3 | 16.1 | 112.7 | -94.0 | 102.3 | - | - | 100.1 | 323.3 | 624.5 | 1,640.9 |
| FCS | 2003 | - | - | - | 7,739.7 | - | 17,079.5 | -673.9 | 4,410.2 | - | - | -134.4 | 5,395.1 | -808.3 | 34,624.5 |
| FMTV | 1996 | - | -97.2 | - | 42.8 | -0.5 | 2,216.3 | 1,051.2 | 2,558.6 | - | - | -549.2 | 201.9 | 501.5 | 4,922.4 |
| GMLRS | 2003 | - | -5,929.7 | - | 224.1 | - | - | -466.9 | 633.0 | - | - | -2.3 | 10.1 | -469.2 | -5,062.5 |
| HIMARS | 2003 | - | -1,689.8 | - | -16.6 | - | 35.5 | -27.8 | -157.3 | - | - | 2.6 | -86.2 | -25.2 | -1,914.4 |
| JAVELIN | 1997 | 269.5 | 469.0 | -0.7 | -4.5 | - | 7.3 | 17.9 | 406.6 | - | - | 52.1 | 24.8 | 338.8 | 903.2 |
| JLENS | 2005 | - | - | - | - | - | - | -73.0 | 189.0 | - | - | 231.8 | 49.6 | 158.8 | 238.6 |
| LONGBOW APACHE | 1996 | 87.7 | 178.5 | - | - | - | 2,083.8 | 58.3 | 1,422.3 | - | - | -13.2 | 450.8 | 132.8 | 4,135.4 |
| LUH | 2006 | 110.5 | 110.5 | -0.6 | 6.9 | 74.4 | 74.4 | -3.1 | -9.6 | - | - | -9.3 | -0.7 | 171.9 | 181.5 |
| PATRIOT PAC-3 | 2002 | - | -463.5 | - | 46.8 | - | - | 12.1 | -280.6 | - | - | - | - | 12.1 | -697.3 |
| PATRIOT/MEADS CAP - FIRE UNIT | 2004 | - | - | - | - | - | - | -8.2 | -635.2 | - | - | -2.7 | -87.1 | -10.9 | -722.3 |
| PATRIOT/MEADS CAP - MISSLE | 2004 | - | - | - | - | - | - | 26.1 | -195.8 | - | - | -4.0 | 2.2 | 22.1 | -193.6 |
| STRYKER | 2004 | 1,579.2 | 3,753.4 | -50.2 | -50.2 | 919.2 | 1,594.1 | -53.5 | -472.5 | - | - | -135.0 | 1,152.8 | 2,259.7 | 5,977.6 |
| WIN-T INCREMENT 1 | 2007 | - | - | - | - | - | - | -3.1 | -3.1 | - | - | 3.1 | 3.1 | - | - |
| WIN-T INCREMENT 2 | 2007 | - | - | - | - | - | - | 74.6 | 74.6 | - | - | -74.6 | -74.6 | - | - |
| **Subtotal** | | 3,293.1 | 4,145.0 | 81.5 | 8,174.6 | 936.8 | 24,493.3 | -92.0 | 10,671.0 | - | - | -839.7 | 8,488.0 | 3,379.7 | 55,971.9 |
| **Navy:** | | | | | | | | | | | | | | | |
| ADS (AN/WQR-3) | 2005 | - | -465.3 | - | - | - | - | -23.5 | -174.7 | - | - | - | -144.9 | -23.5 | -784.9 |
| AGM-88E AARGM | 2003 | -2.6 | 41.4 | 11.3 | 0.6 | - | 0.7 | 35.8 | 68.7 | - | - | -34.2 | -25.4 | 10.3 | 86.0 |
| AIM-9X | 1997 | - | 12.9 | 14.6 | 64.3 | - | 200.2 | 1.1 | 150.3 | - | - | 3.5 | -227.6 | 19.2 | 200.1 |
| CEC | 2002 | 139.2 | 21.0 | 6.5 | 13.4 | -24.9 | 212.7 | -213.1 | -107.0 | - | - | 149.4 | -56.4 | 57.1 | 83.7 |
| CH-53K | 2006 | - | - | - | - | - | - | -52.7 | 21.4 | - | - | 2.3 | 22.6 | -50.4 | 44.0 |
| COBRA JUDY REPLACEMENT | 2003 | - | - | - | - | - | - | 92.7 | 88.3 | - | - | - | - | 92.7 | 88.3 |
| CVN 21 | 2000 | - | - | - | 88.0 | - | -688.9 | -273.5 | -3,113.2 | - | - | - | - | -273.5 | -3,714.1 |
| CVN 68 | 1995 | - | - | - | -72.8 | - | -5.3 | -7.9 | 685.1 | - | 114.7 | - | - | -7.9 | 721.7 |
| DDG 1000 | 2005 | -6,319.2 | -6,319.2 | -47.7 | 85.9 | 449.2 | -233.5 | 441.7 | 9.3 | - | - | - | - | -5,476.0 | -6,457.5 |
| DDG 51 | 1987 | - | 24,694.7 | - | 89.1 | - | 1,480.1 | -77.8 | 3,200.5 | - | - | - | - | -77.8 | 29,464.4 |
| E-2D AHE | 2002 | - | - | - | 208.1 | - | 374.3 | 20.9 | 517.6 | - | - | 6.8 | 68.9 | 27.7 | 1,168.9 |
| EA-18G | 2004 | - | 59.4 | - | - | - | - | 26.2 | 8.2 | - | - | -33.7 | -20.1 | -7.5 | 47.5 |
| EFV | 2007 | - | -2,365.8 | - | 364.7 | - | 363.9 | -23.8 | 5,884.8 | - | - | -0.3 | 423.5 | -24.1 | 4,671.1 |
| ERM | 2005 | - | - | - | - | - | - | 44.8 | 44.8 | - | - | - | - | 44.8 | 44.8 |
| F/A-18E/F | 2000 | -49.7 | 1,502.5 | - | 868.8 | - | 200.1 | -44.0 | 134.7 | - | - | -45.3 | 1,666.8 | -139.0 | 4,372.9 |
| H-1 UPGRADES (4BW/4BN) | 1996 | - | - | -11.7 | 166.3 | 60.9 | 529.7 | 71.1 | 2,516.8 | - | - | -64.5 | 745.0 | 55.8 | 3,957.8 |
| JSOW - BASELINE/BLU-108 | 1990 | - | -2,059.3 | - | 2.4 | - | 76.6 | -5.5 | -97.3 | - | - | -1.4 | -12.8 | -6.9 | -2,090.4 |
| JSOW - UNITARY | 1990 | - | - | - | 5.9 | 16.0 | 49.2 | -5.1 | -247.0 | - | - | -4.1 | -8.8 | 6.8 | -200.7 |
| LCS | 2004 | - | - | 60.9 | 127.5 | 38.5 | 102.8 | 704.0 | 1,192.2 | - | - | - | - | 803.4 | 1,422.5 |
| LHA REPLACEMENT | 2006 | - | - | - | - | - | - | -211.9 | -48.2 | 249.7 | 249.7 | - | - | 37.8 | 201.5 |
| LPD 17 | 1996 | - | -3,024.6 | 4.8 | 320.5 | - | - | 28.9 | 3,993.0 | 370.9 | 1,201.0 | - | - | 404.6 | 2,489.9 |
| MH-60R | 2006 | - | - | 6.4 | 35.0 | 14.2 | 187.3 | 690.4 | 735.7 | - | - | -284.3 | -305.7 | 426.7 | 652.3 |
| MH-60S | 1998 | 59.0 | 514.0 | 0.9 | 128.2 | -0.2 | -36.6 | -138.2 | 385.2 | - | - | 44.7 | 243.3 | -33.8 | 1,234.1 |
| MUOS | 2004 | - | - | - | - | - | - | 281.1 | -71.0 | - | - | - | - | 281.1 | -71.0 |
| NMT | 2002 | 0.6 | 0.6 | - | - | - | - | -40.3 | -181.8 | - | - | -1.5 | -65.4 | -41.2 | -246.6 |
| P-8A (MMA) | 2004 | -175.4 | -175.4 | 11.1 | 270.5 | 137.8 | 137.8 | 343.5 | -553.1 | - | - | 1.2 | 9.0 | 318.2 | -311.2 |
| RMS | 2006 | - | -3.7 | 88.5 | 88.5 | - | - | 3.7 | 1.0 | - | - | -10.9 | -10.9 | 81.3 | 74.9 |
| SM-6 | 2004 | - | - | - | - | - | - | 34.9 | -73.5 | - | - | -2.9 | -100.3 | 32.0 | -173.8 |

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## Distribution of Cost Changes (Base Year Dollars in Millions)
## As Of December 31, 2007

| Program | Base Year | Quantity This Qtr | Quantity To Date | Schedule This Qtr | Schedule To Date | Engineering This Qtr | Engineering To Date | Estimating This Qtr | Estimating To Date | Other This Qtr | Other To Date | Support This Qtr | Support To Date | Total This Qtr | Total To Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SSDS | 2004 | - | 361.6 | - | 7.7 | - | | -2.7 | -316.4 | - | | - | -6.4 | -2.7 | 46.5 |
| SSGN | 2002 | - | - | - | - | - | 6.8 | 10.3 | -8.1 | - | | -0.2 | -0.4 | 10.1 | -1.7 |
| SSN 774 (VIRGINIA CLASS) | 1995 | - | - | -168.3 | 1,708.0 | - | 956.0 | -571.6 | 14,737.4 | - | 216.3 | -95.0 | 501.0 | -834.9 | 18,118.7 |
| T-45TS | 1995 | -20.3 | 841.9 | 7.5 | -71.7 | -10.4 | 77.3 | 27.2 | 320.1 | - | | -1.5 | 39.7 | 2.5 | 1,207.3 |
| TACTICAL TOMAHAWK | 1999 | -168.7 | 235.4 | -14.4 | 151.3 | -1.6 | 19.7 | 71.3 | 275.5 | - | | - | 46.4 | -113.4 | 728.3 |
| T-AKE | 2000 | 343.5 | 16.8 | - | | - | | 418.2 | 338.8 | - | | - | | 761.7 | 355.6 |
| TRIDENT II MISSILE | 1983 | - | -3,970.8 | - | | -193.7 | 51.7 | -162.4 | 2,629.6 | - | | 312.5 | 1,115.0 | -43.6 | -174.5 |
| V-22 | 2005 | - | | - | 398.9 | - | 157.1 | -22.3 | -264.9 | - | | -115.4 | -68.7 | -137.7 | 222.4 |
| VH-71 | 2003 | -75.0 | 272.0 | 130.4 | 130.4 | - | | 418.7 | -302.6 | - | | 4.7 | -21.9 | 478.8 | 77.9 |
| VTUAV | 2006 | - | | - | | 35.7 | 35.7 | -11.8 | -518.6 | - | | -9.1 | -8.7 | 14.8 | -491.6 |
| **Subtotal** | | -6,268.6 | 10,190.1 | 100.8 | 5,179.5 | 521.5 | 4,255.4 | 1,878.4 | 31,861.6 | 620.6 | 1,781.7 | -179.2 | 3,796.8 | -3,326.5 | 57,065.1 |
| **Air Force:** | | | | | | | | | | | | | | | |
| AEHF | 2002 | 784.9 | -64.1 | - | 1,037.3 | -6.2 | 37.7 | 4.6 | 442.0 | - | | 6.2 | 6.2 | 789.5 | 1,459.1 |
| AMRAAM | 1992 | -103.5 | -1,065.5 | -8.6 | 775.2 | -4.5 | 867.9 | 176.2 | 207.7 | - | | 51.6 | 92.8 | 111.2 | 878.1 |
| B-2 EHF INCREMENT 1 | 2007 | - | | - | | - | | -18.7 | -18.7 | - | | -4.6 | -4.6 | -23.3 | -23.3 |
| B-2 RMP | 2004 | - | | 86.6 | 86.6 | - | | -2.5 | -124.5 | - | | -8.4 | -16.8 | 75.7 | -54.7 |
| C-130 AMP | 2000 | -157.9 | -777.6 | -36.4 | 63.0 | - | 69.2 | 370.8 | 1,528.6 | - | | -290.1 | 303.9 | -113.6 | 1,187.1 |
| C-130J | 1996 | 2,129.1 | 6,730.5 | 175.5 | -264.1 | - | 126.2 | 145.7 | 259.8 | - | | 435.7 | 2,221.6 | 2,886.0 | 9,074.0 |
| C-17A | 1996 | - | -824.7 | - | 1,418.4 | - | 371.9 | -38.3 | 13,640.0 | - | 411.0 | -85.7 | 2,397.3 | -124.0 | 17,413.9 |
| C-5 AMP | 2006 | - | 257.9 | - | 3.0 | - | 13.9 | -23.9 | -9.8 | - | | 19.0 | 223.6 | -4.9 | 488.6 |
| C-5 RERP | 2000 | - | -521.0 | - | 166.8 | - | -52.3 | -3,906.4 | -274.2 | - | | -599.3 | 360.7 | -4,505.7 | -320.0 |
| F-22 | 2005 | - | 348.2 | - | | - | | -645.6 | 1,587.3 | - | | -10.2 | 774.6 | -655.8 | 2,710.1 |
| FAB-T | 2002 | 33.6 | 33.6 | - | | - | | 243.9 | 243.9 | - | | 42.9 | 42.9 | 320.4 | 320.4 |
| GBS | 1997 | 7.8 | 231.2 | 8.0 | 35.8 | 7.9 | 85.8 | -63.8 | -84.7 | - | | 0.1 | 7.5 | -40.0 | 275.6 |
| GLOBAL HAWK (RQ-4A/B) | 2000 | - | -321.6 | -1.2 | -528.9 | 62.9 | 3,052.4 | -136.5 | 971.0 | - | | 21.7 | 578.7 | -53.1 | 3,751.6 |
| JASSM | 1995 | - | -230.9 | - | -20.8 | -97.5 | 10.8 | 249.5 | 686.5 | - | | 17.0 | 4.1 | 169.0 | 449.7 |
| JDAM | 1995 | -46.5 | 1,225.2 | - | | - | 12.5 | 27.7 | 801.1 | - | | -8.5 | 183.0 | -27.3 | 2,221.8 |
| JPATS | 2002 | - | -58.5 | - | 10.4 | 178.2 | 344.5 | -200.6 | 141.5 | - | | 24.8 | -52.4 | 2.4 | 385.5 |
| MINUTEMAN III GRP | 1993 | - | -34.1 | - | 0.4 | - | | -15.8 | 116.5 | - | | -1.4 | 0.1 | -17.2 | 82.9 |
| MINUTEMAN III PRP | 1994 | - | -10.4 | - | -26.9 | - | 21.3 | -25.4 | 93.1 | - | | -4.1 | 25.9 | -29.5 | 103.0 |
| MP RTIP | 2000 | - | | - | 129.4 | - | -289.7 | -11.2 | -174.3 | - | | - | | -11.2 | -334.6 |
| MPS | 2004 | - | | - | -15.5 | - | 6.0 | 3.4 | -139.1 | - | | - | -3.6 | 3.4 | -152.2 |
| NAS | 2005 | - | -15.1 | - | 11.6 | - | | 30.4 | 39.3 | - | | -3.5 | 14.5 | 26.9 | 50.3 |
| NAVSTAR GPS - SPACE & CONTROL | 2000 | - | 20.0 | - | | - | 391.9 | -30.0 | 330.2 | - | | -1.6 | 205.4 | -31.6 | 947.5 |
| NAVSTAR GPS - USER EQUIPMENT | 2000 | - | | - | | - | 251.6 | 562.7 | 739.4 | - | | -1.1 | 1.8 | 561.6 | 992.8 |
| NPOESS | 2002 | - | -432.2 | - | 682.2 | 2.8 | -677.1 | 15.4 | 4,252.1 | - | | - | | 18.2 | 3,825.0 |
| SBIRS HIGH | 1995 | 604.4 | -244.2 | - | 301.5 | 1.6 | 453.8 | 625.4 | 5,265.4 | - | | 4.4 | 102.7 | 1,235.8 | 5,879.2 |
| SDB I | 2001 | - | | - | | - | | -1.9 | -273.8 | - | | 0.8 | -0.2 | -1.1 | -274.0 |
| WGS | 2001 | - | 560.5 | - | | - | 59.7 | 6.4 | 182.1 | - | | - | -18.3 | 6.4 | 784.0 |
| **Subtotal** | | 3,251.9 | 4,807.2 | 223.9 | 3,865.4 | 145.2 | 5,158.0 | -2,658.5 | 30,428.4 | - | 411.0 | -394.3 | 7,451.4 | 568.2 | 52,121.4 |
| **DoD:** | | | | | | | | | | | | | | | |
| BMDS | 2002 | - | | - | -1,417.0 | - | 47,553.5 | -337.9 | -1,478.3 | - | | - | | -337.9 | 44,658.2 |
| CHEM DEMIL-ACWA | 1994 | - | | - | -175.1 | - | | 81.3 | 3,716.5 | - | | - | | 81.3 | 3,541.4 |
| CHEM DEMIL-CMA | 1994 | - | | - | 8,011.5 | - | | -695.3 | 2,926.5 | - | 7.6 | - | | -695.3 | 10,945.6 |
| DIMHRS | 2007 | - | | - | | - | | 15.6 | 15.6 | - | | 0.2 | -112.9 | 15.8 | -97.3 |
| F-35 (JSF) | 2002 | - | -16,249.1 | - | 8,797.1 | - | 9,686.7 | 11,888.9 | 30,737.5 | - | | -11,276.0 | -57.7 | 612.9 | 32,914.5 |
| JTRS GMR | 2002 | -1,468.6 | -1,865.7 | 0.1 | 364.4 | - | -72.7 | 1,955.7 | 1,306.0 | - | | 244.8 | 73.9 | 732.0 | -194.1 |
| JTRS HMS | 2004 | -3,902.6 | -3,902.6 | - | | - | | -1,520.6 | -1,367.0 | - | | -627.6 | -627.6 | -6,050.8 | -5,897.2 |
| JTRS NED | 2002 | - | | - | | - | 648.1 | -91.3 | 282.2 | - | | - | | -91.3 | 930.3 |
| MIDS | 2003 | 112.2 | 224.1 | -0.2 | -0.2 | 48.5 | 267.0 | -2.5 | -5.3 | - | | -18.7 | -21.3 | 139.3 | 464.3 |
| **Subtotal** | | -5,259.0 | -21,793.3 | -0.1 | 15,580.7 | 48.5 | 58,082.6 | 11,293.9 | 36,133.7 | - | 7.6 | -11,677.3 | -745.6 | -5,594.0 | 87,265.7 |
| **Grand Total** | | -4,982.6 | -2,651.0 | 406.1 | 32,800.2 | 1,652.0 | 91,989.3 | 10,421.8 | 109,094.7 | 620.6 | 2,200.3 | -13,090.5 | 18,990.6 | -4,972.6 | 252,424.1 |

# Appendix C: Contingency Tables and Fisher's Exact Tests of Independence

| | Breach | No breach | Total |
|---|---|---|---|
| Army | 3 | 9 | 12 |
| Navy | 3 | 25 | 28 |
| Air Force | 8 | 15 | 23 |
| DoD | 4 | 4 | 8 |
| Total | 18 | 53 | 71 |

P-value: 0.001

**Figure 11: Small NM group, NM breach by service**

| | No quantity change | Quantity increase | Quantity decrease | Total |
|---|---|---|---|---|
| No breach | 23 | 17 | 13 | 53 |
| Breach | 2 | 4 | 12 | 18 |
| Total | 25 | 21 | 25 | 71 |

P-value: 0.000

| | No quantity change | Quantity change | Total |
|---|---|---|---|
| No breach | 23 | 30 | 53 |
| Breach | 2 | 16 | 18 |
| Total | 25 | 46 | 71 |

P-value: 0.021

**Figure 12: Small NM group, NM breach by quantity change**

Baseline estimate

| | <$3,500B | between | >$7,950B | Total |
|---|---|---|---|---|
| No breach | 21 | 15 | 17 | 53 |
| Breach | 2 | 9 | 7 | 18 |
| Total | 23 | 24 | 24 | 71 |

P-value: 0.004

Baseline estimate

| | <$3,500B | >$3,500B | Total |
|---|---|---|---|
| No breach | 21 | 32 | 53 |
| Breach | 2 | 16 | 18 |
| Total | 23 | 48 | 71 |

P-value: 0.039

Current estimate

| | <$3,500B | between | >$7,950B | Total |
|---|---|---|---|---|
| No breach | 20 | 13 | 20 | 53 |
| Breach | 0 | 6 | 12 | 18 |
| Total | 20 | 19 | 32 | 71 |

P-value: 0.004

| Current estimate | <$3,500B | >$3,500B | Total |
|---|---|---|---|
| No breach | 20 | 33 | 53 |
| Breach | 0 | 18 | 18 |
| Total | 20 | 51 | 71 |

P-value: 0.002

**Figure 13: Small NM group, NM breach by $ size of project**

| Current estimate | Below average value | Above average value | Total |
|---|---|---|---|
| No breach | 44 | 9 | 53 |
| Breach | 14 | 4 | 18 |
| Total | 58 | 13 | 71 |

P-value: 0.726

**Figure 14: Small NM group, NM breach by average $ of project**

| Current estimate | Below median value | Above median value | Total |
|---|---|---|---|
| No breach | 30 | 23 | 53 |
| Breach | 6 | 12 | 18 |
| Total | 36 | 35 | 71 |

P-value: 0.107

**Figure 15: Small NM group, NM breach by median $ of project**

Estimating[20]

| | Negative cost-growth | Positive cost-growth | Total |
|---|---|---|---|
| No breach | 25 | 28 | 53 |
| Breach | 1 | 17 | 18 |
| Total | 26 | 45 | 71 |

P-value: 0.001

Quantity

| | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 12 | 20 | 21 | 53 |
| Breach | 11 | 3 | 4 | 18 |
| Total | 23 | 23 | 25 | 71 |

P-value: 0.001

20 All programs experienced a change in estimating cost. Because a chi-square test of independence cannot be conducted if a category has no entries, the “no cost-growth” category was excluded.

| Engineering | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 3 | 17 | 33 | 53 |
| Breach | 5 | 3 | 10 | 18 |
| Total | 8 | 20 | 43 | 71 |

P-value: 0.016

| Schedule | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 9 | 19 | 25 | 53 |
| Breach | 5 | 0 | 13 | 18 |
| Total | 14 | 19 | 38 | 71 |

P-value: 0.002

| Support | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 19 | 12 | 22 | 53 |
| Breach | 2 | 3 | 13 | 18 |
| Total | 21 | 15 | 35 | 71 |

P-value: 0.005

**Figure 16: Small NM group, NM breach by cost category**

Largest cost category

| | Estimating | Quantity | Engineering | Schedule | Support | total |
|---|---|---|---|---|---|---|
| No breach | 16 | 16 | 15 | 5 | 1 | 53 |
| Breach | 9 | 3 | 2 | 2 | 2 | 18 |
| total | 25 | 19 | 17 | 7 | 3 | 71 |

P-value: 0.001

Largest absolute cost category

| | Estimating | Quantity | Engineering | Schedule | Support | total |
|---|---|---|---|---|---|---|
| No breach | 27 | 16 | 8 | 0 | 2 | 53 |
| Breach | 7 | 6 | 2 | 2 | 1 | 18 |
| total | 34 | 22 | 10 | 2 | 3 | 71 |

P-value: 0.002

**Figure 17: Small NM group, NM breach by largest cost category**

## Second Set

| | Breach | No breach | Total |
|---|---|---|---|
| Army | 7 | 5 | 12 |
| Navy | 9 | 19 | 28 |
| Air Force | 11 | 12 | 23 |
| DoD | 4 | 4 | 8 |
| Total | 31 | 40 | 71 |

P-value: 0.004

**Figure 18: Large NM group, NM breach by service**

| | No quantity change | Quantity increase | Quantity decrease | Total |
|---|---|---|---|---|
| No breach | 19 | 15 | 6 | 40 |
| Breach | 6 | 6 | 19 | 31 |
| Total | 25 | 21 | 25 | 71 |

P-value: 0.002

| | No quantity change | Quantity change | Total |
|---|---|---|---|
| No breach | 19 | 21 | 40 |
| Breach | 6 | 25 | 31 |
| Total | 25 | 46 | 71 |

P-value: 0.023

**Figure 19: Large NM group, NM breach by quantity change**

Baseline estimate

| | <$3,500B | between | >$7,950B | Total |
|---|---|---|---|---|
| No breach | 19 | 11 | 10 | 40 |
| Breach | 4 | 13 | 14 | 31 |
| Total | 23 | 24 | 24 | 71 |

P-value: 0.000

Baseline estimate

| | <$3,500B | >$3,500B | Total |
|---|---|---|---|
| No breach | 19 | 21 | 40 |
| Breach | 4 | 27 | 31 |
| Total | 23 | 48 | 71 |

P-value: 0.002

Current estimate

| | <$3,500 | between | >$7,950 | Total |
|---|---|---|---|---|
| No breach | 17 | 13 | 10 | 40 |
| Breach | 3 | 6 | 22 | 31 |
| Total | 20 | 19 | 32 | 71 |

P-value: 0.002

| Current estimate | <$3,500B | >$3,500B | Total |
|---|---|---|---|
| No breach | 17 | 23 | 40 |
| Breach | 3 | 28 | 31 |
| Total | 20 | 51 | 71 |

P-value: 0.003

**Figure 20: Large NM group, NM breach by $ size of project**

| Current estimate | Below average value | Above average value | Total |
|---|---|---|---|
| No breach | 36 | 4 | 40 |
| Breach | 22 | 9 | 31 |
| Total | 58 | 13 | 71 |

P-value: 0.062

**Figure 21: Large NM group, NM breach by average $ of project**

| Current estimate | Below median value | Above median value | Total |
|---|---|---|---|
| No breach | 27 | 13 | 40 |
| Breach | 9 | 22 | 31 |
| Total | 36 | 35 | 71 |

P-value: 0.002

**Figure 22: Large NM group, NM breach by median $ of project**

| | Estimating[21] | | |
|---|---|---|---|
| | Negative cost-growth | Positive cost-growth | Total |
| No breach | 22 | 18 | 40 |
| Breach | 4 | 27 | 31 |
| Total | 26 | 45 | 71 |

P-value: 0.000

| | | Quantity | | |
|---|---|---|---|---|
| | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
| No breach | 5 | 17 | 18 | 40 |
| Breach | 18 | 6 | 7 | 31 |
| Total | 23 | 23 | 25 | 71 |

P-value: 0.002

21 All programs experienced a change in estimating cost. Because a chi-square test of independence cannot be conducted if a category has no entries, the "no cost-growth" category was excluded.

| Engineering | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 3 | 15 | 22 | 40 |
| Breach | 5 | 5 | 21 | 31 |
| Total | 8 | 20 | 43 | 71 |

P-value: 0.009

| Schedule | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 8 | 17 | 15 | 40 |
| breach | 6 | 2 | 23 | 31 |
| total | 14 | 19 | 38 | 71 |

P-value: 0.000

| Support | Negative cost-growth | No cost-growth | Positive cost-growth | Total |
|---|---|---|---|---|
| No breach | 17 | 11 | 12 | 40 |
| Breach | 4 | 4 | 23 | 31 |
| Total | 21 | 15 | 35 | 71 |

P-value: 0.000

**Figure 23: Large NM group, NM breach by cost category**

Largest cost category

| | Estimating | Quantity | Engineering | Schedule | Support | total |
|---|---|---|---|---|---|---|
| No breach | 10 | 14 | 10 | 5 | 1 | 40 |
| Breach | 15 | 5 | 7 | 2 | 2 | 31 |
| total | 25 | 19 | 17 | 7 | 3 | 71 |

P-value: 0.000

Largest absolute cost category

| | Estimating | Quantity | Engineering | Schedule | Support | total |
|---|---|---|---|---|---|---|
| No breach | 21 | 11 | 6 | 0 | 2 | 40 |
| Breach | 13 | 11 | 4 | 2 | 1 | 31 |
| total | 34 | 22 | 10 | 2 | 3 | 71 |

P-value: 0.003

**Figure 24: Large NM group, NM breach by largest cost category**

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